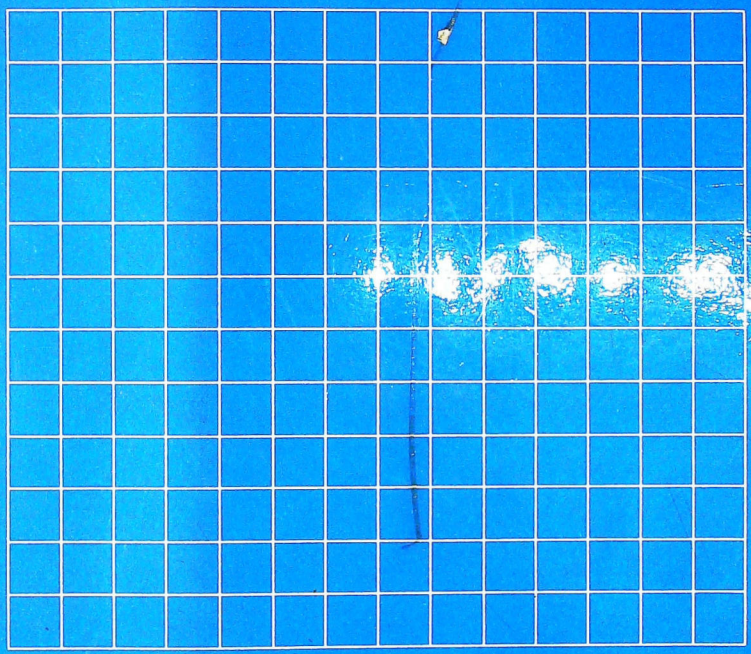
INSTRUCTION MANUAL

-TR-4122B
Spectrum Analyzer



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INSTRUCTION MANUAL

-*TR*-4122B

Spectrum Analyzer

MANUAL NUMBER 0995 A 007

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CHAPTER 1
GENERAL

1-1 Introduction

The ***-TR-4122B* Spectrum Analyzer** is a three-power source instrument covering a wide frequency range from 100 kHz to 1,500 MHz. This analyzer has a wide measuring range from a broad band of 100 MHz/div. to narrow band of 2 kHz/div., low noise level, and wide dynamic range. The incorporated tracking generator and frequency counter enable direct viewing of frequency characteristics and frequency measurement of such like a mixed signal.

The ***-TR-4122B*** Spectrum Analyzer guarantees a 90 dB dynamic range for the measurement of frequency characteristics of a four-terminal network of various filters (using tracking generator), amplifier, and cable. Display on 100 dB CRT graticule helps the observation of filters having high attenuation. Measurement of 3 dB loss or ripple characteristics, etc. are also possible using **"VERT. MODE", 2 dB/DIV., LINEAR**, facilitating the correct adjustment and inspection. Finally, with the wide dynamic range of average noise level below −85 dBm, residual spurious response below −100 dBm, and distortion spurious response below −70 dBm for an input of −30 dBm, plus the employment of an IF filter superior in selectivity, the analysis of low spurious signal content is easy.

1-2 Feature

1. An IF filter superior in selectivity is employed, contributing to an outstanding increase in frequency resolution.
2. An auto scan function is incorporated, which enables the selection of optimum band width and a scanning time simply by changing the scanning width.
3. A 100 dB CRT graticule makes it easier to see frequency characteristics above 80 dB.
4. A tracking generator and frequency counter are incorporated, enabling the measurement of frequency characteristics of a four-terminal network of various filters, amplifiers, and cables as well as the high-sensitivity and selective measurement of frequency in a mixed signal.
5. ***-TR-1927*** battery pack (accessory) allows measurement where an AC power supply is not available.

1-3 Accessories

Standard accessories supplied together with the instrument are listed below. Please check the items and quantity on delivery.

(1)	Input cable	**MI-02**	2
(2)	Input cable	**MI-04**	2
(3)	Connection cable	**MC-61**	1
(4)	NP-BNCJ adaptor	JUG-201A/U	2
(5)	Fuse	1 A (Slow Blow)	2
	(0.5 A for AC 200 V specification)		
(6)	Hexagonal wrench	3 mm/4 mm	1 each
(7)	Instruction manual		1
(8)	Filter (Light blue)	MSP-0127-0133-6	1
(9)	CRT hood	***-TR-1656***	1
(10)	Front cover		1
(11)	Adjustment board	**CY-822**	1

1-4 Specification

Electrical performance and general specification of ***-TR-4122B*** are shown in Table 1-1. The specified electrical performance applies to the power supply AC 100 V ±10% and to the environmental and operational conditions in temperatures between 0°C to +40°C, relative humidity below 85%, and a warm up of about one hour.

Spectrum Analyzer Section

Frequency Specifications

Frequency Measurement Range:	100 kHz to 1500 MHz
Center Frequency Accuracy:	Within ±10 MHz (with START/CENTER switch)
Scan Width:	By DISPERSION/DIV. switch 100 MHz/div. to 2 kHz/div. in 1–2–5 sequence and zero scan Operates as a fixed tuned receiver at zero scan.
Scan Linearity:	Within ±10%
Stability:	
Residual FM;	Less than 10 kHzp-p (at scan time of less than 50 ms/div.)
Noise Sidebands;	Less than –70 dB (20 kHz away from the carrier with IF B.W. 1 kHz, and with the video filter ON)
IF Band Width:	500 Hz, 1, 10, 100 kHz, 1, 3 MHz
IF Band Width Accuracy:	±20% of resolution B.W.
IF Band Width Selectivity:	60 dB/3 dB IF Band Width ratio <5 : 1
IF Band Width Switching Accuracy:	Within 1 dB (+20°C to +30°C)

Amplitude Specifications

Reference Level:	+50 dBm to –62 dBm, 10 dB step, 0 to –12 dB continuously variable
Reference Level Accuracy:	Within ±1 dB (+20°C to +30°C)
Y-axis Scale Selection:	10 dB/div., 2 dB/div., LINEAR
Level Display Accuracy:	Within ±1 dB for 10 dB Within ±2 dB for 80 dB
Dynamic Range:	
Average Noise Level;	Below –85 dBm (at IF B.W. 1 MHz and with the video filter ON)
Spurious Response;	Below –70 dBm (at –30 dBm input)
Residual Response;	Below –100 dBm (without input signal and at INPUT ATT. 0 dB)
CRT Dynamic Range:	90 dB (10 dB/div.), 20 dB (2 dB/div.)
Video Filter:	ON/OFF. Filter of 1/30 IF band width inserted automatically when ON.
Frequency Response:	±1 dB (at 100 kHz–1500 MHz), at INPUT ATT. 10 dB
Calibration Output:	Amplitude –30 dBm ±0.5 dB Frequency 200 MHz ±30 kHz, crystal oscillator
Gain Compression:	Less than –1 dB at –10 dBm input

Input Specifications

Input Connector:	N type
Input Impedance:	50 Ω normal, V.S.W.R. 1.5 or less (at INPUT ATT. 10 dB or greater)
Input Attenuator:	0 to 50 dB on 10 dB step
Max. Input Sensitivity:	–115 dBm
Breakdown Input Level:	Maximum input to input mixer (at INPUT ATT. 0 dB) +10 dBm Maximum input to input attenuator +20 dBm, DC; ±50 V

Scan Specifications

Scan Time:	0.2 ms/div. to 10 s/div. in 1, 2, 5 sequence and automatic (automatically controlled according to DISPERSION, IF band width, and video filter setting)
Scan Trigger Mode:	AUTO, LINE, VIDEO, SINGLE

Tracking Generator Section

Frequency Range:	400 kHz to 1500 MHz
Output Level:	0 dBm to –50 dBm on 10 dB step
Output Level Accuracy:	±1 dB
Output S/N Ratio:	More than 30 dB
Output Connector:	N type
Output Impedance:	50 Ω V.S.W.R. 1.5 or less (at attenuator 10 dB or greater)
Frequency Response:	±1 dB
Stability:	Depends on the stability of the spectrum analyzer.
T.G. Mode:	TUNED AMP., NORMAL (Frequency at marker indicated point is output.)

Frequency Counter Section

Frequency Range:	400 kHz to 1500 MHz
Resolution:	1 kHz, 100 Hz
Display:	Decimal 8 digits LED display
Time Base Stability:	Aging rate 5×10^{-7}/month

General Specifications

CRT:	Display area – 10 cm x 8 cm (10 div. x 10 div.) CRT specification – Square type P7 phosphor
Data Input/Output:	DC voltage (+5 V, –15 V, +15 V), Ramp signal output (+6 V to –6 V), Blanking output (Blanking at Low), YIG drive output, IF gain control signal, IF gain setting output, Input attenuator setting output, External Frequency Counter control signal
X-axis Output:	Approx. ±5 V, output impedance 1 kΩ
Y-axis Output:	Approx. 0 to 5 V, output impedance 10 kΩ
Z-axis Output:	Approx. 0 to +15 V (Blanking at Low)
Scan Display:	LED display on front panel
Warning Display:	LED display on front panel
Operating Temperature Range:	0 to 40°C
Power Requirement:	AC 100 V ±10% or (120 V, 200 V, 220 V, 240 V) ±10%, 50/60 Hz, 100 VA DC drive is possible for approximately one hour by using the ***-TR-1927*** battery pack (accessory)
Dimensions:	Approx. 300 (W) x 200 (H) x 500 (D) mm
Weight:	Approx. 20 kg

For the dBμ display and 75 Ω input impedance and AC line voltage (120 V, 200 V, 220 V or 240 V), a special order should be made. Please specify when giving an order.

Table 1 – 1-*TR*-4122B Specifications

CHAPER 2
OPERATING INSTRUCTIONS

2-1 General

This Chapter describes the operating procedure, including the preparations and precautions, for **-TR-4122B** in the following order:

Panel description . . . Name and outline of panel controls and other external parts

Basic operation . . . Basic operation and level check by referring to the internal reference signal

Functions and control of the panel switches . . . Control and function of each switch on the panel

Tracking generator . . . Operation and use of the built-in tracking generator

Frequency counter . . . Operation and use of frequency counter

AUX. OUTPUT connector . . . Description of output signal, output level, and use of each pin

2-2 Preparation and Precautions Prior to Use

1. Keep the AC line voltage within 100 V (or 120 V, 200 V, 220 V, 240 V) ±10% during operation.
2. Always confirm that the **POWER** switch is **OFF** before connecting the power cable to the AC line.
3. Power cable
   The power cable has a three-pin plug, and the round center pin of this plug is a ground pin. When connecting the cable to the AC line through an adapter, always connect the lead of the adaptor [Fig. 2-1] or the ground terminal on the rear of the instrument to an earth ground.
4. This instrument does not have a cooling fan. Be sure to keep good ventilation around the instrument. Never place articles close to the instrument or operate with the CRT at the top.
5. Operating temperature range is 0°C to +40°C.
6. Storage temperature range is −20°C to +70°C.
7. When the AC line is noisy, use a noise filter.

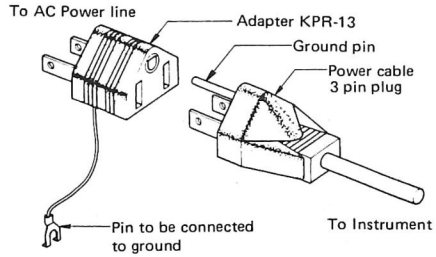


Fig. 1 Power Cable Plug and Adapter

2-3 Panel Description

Front panel Refer to [Fig. 2-2].

1 **POWER** switch
Supplies the power to the instrument.

2 **AC LINE ON** lamp
Indicates that the instrument is being run on AC power.

3 **BATT. ON** lamp
Indicates that the DC power is being applied. The -TR-1927 **DC Power Supply Unit** is available as the DC power source.

4 **INTENSITY** control
Adjusts the brightness of the trace on the CRT display.

5 **FOCUS** control
Adjusts the focus of the trace on the CRT display.

6 **BASELINE CLIPPER** control
Makes the spectrum easier to see by cancelling the noise at the bottom of the CRT display up to an arbitrary height. Normally this control is set fully counterclockwise.

7 **TRACE ALIGN** control
A semi-fixed resistor which horizontally adjusts the trace.

8 **ASTIG.**
A semi-fixed resistor which adjusts the entire CRT display to a uniform focus.

9 **HORIZ. POSI.**
A semi-fixed resistor which adjusts the position of the horizontal axis of the CRT display.

10 **HORIZ. GAIN**
A semi-fixed resistor which adjusts the expansion of the horizontal axis of the CRT display.

11 **VERT. POSI.**
A semi-fixed resistor which adjusts the position of the vertical axis of the CRT display.

12 **VERT. GAIN**
A semi-fixed resistor which adjusts the height of the vertical axis of the CRT display.

13 **CAL. OUT.** connector
Used as the vertical axis and horizontal axis calibration signal. The output signal has a 200 MHz frequency, –30 dBm amplitude, and 50 Ω output impedance.

14 **INPUT** connector
Signal to be measured is input at this terminal.

INPUT ATT. setting	Maximum Input Level
0dB	+10dBm
10dB	+20dBm
20dB	+20dBm
30dB	+20dBm
40dB	+20dBm
50dB	+20dBm

15 **INPUT ATT.** switch
Used when the input signal level is high.

16 IF GAIN (**REF. LEVEL**)
Changes the IF gain from 0 dB to 50 dB in 10 dB steps.
The reference level is the sum of the value of this switch and the value of the **FINE** control.

17 **FINE** control
Control continuously adjusts the gain of the IF stage. It can be adjusted between 0 and 12 dB.

18 **ADJ.** control
A semi-fixed resistor which calibrates the absolute value of the reference level.

19 **VERT. MODE** switch
Selects the gain of the vertical axis from among **LINEAR, 2 dB/DIV.** and **10 dB/DIV.**

20 Frequency display
Displays the frequency set by the **TUNING** control.

21 **TUNING** control
Sets the frequency. When this control is turned, the frequency display changes and the frequency is shifted.

22 **FINE TUNING** control
This is for fine tuning of the frequency. Its control width is available to 2 MHz or more.

23 **ZERO CAL.** control
Calibrates the frequency display.

24 **START/CENTER** switch
Sets the position of the value indicated on the frequency display on the CRT. When this switch is set to **START**, the value indicated at the frequency display is at the left side of the CRT and when this switch is set to **CENTER**, the value indicated at the frequency display is at the center of the CRT.

25 **SCAN MODE** selector
Selects the scan mode.
When this switch is set to **MANUAL**, sweep is performed at the value set by **TIME/DIV.** switch, and when it is set to **MANUAL SWEEP**, sweep is manually effected with

MANUAL SWEEP control. At **AUTO** position, sweep is performed in the optimum value automatically selected according to the position of the **DISPERSION/DIV., BAND WIDTH**, and **VIDEO FILTER** switches.

26 **TIME/DIV.** switch
This switch sets the sweep time. When **MANUAL** is set at the **SCAN MODE** switch, sweep is performed at the time set by this switch.

27 **MANUAL SWEEP** control
When the **SCAN MODE** switch is set at **MANUAL**, turning this control permits **MANUAL SWEEP**. When the **COUNTER POWER** switch has been set to **ON**, the read position on the counter can be specified by moving the intensity modulation with this control.

28 **SCANNING** lamp
Indicates that the instrument is scanning.

29 **SCAN TRIGGER** selector
Selects the **SCAN MODE**.
When set to **AUTO**, sweep is repeated automatically in synchronization with the time set internally. At **LINE** position, sweep is synchronized with the power line frequency. At **VIDEO** position, sweep is started by the amplitude of the input signal as in the case of an oscilloscope. At **SINGLE** position, sweep is performed by the pushbutton at the left.

30 **DISPERSION/DIV.** switch
Switch selects the horizontal axis scale of the CRT display.
The horizontal axis scale can be switched from 2 kHz/DIV. to 100 MHz/DIV. in 1, 2, 5 sequence. At "0" position, the instrument is operated as a tuned receiver of the frequency indicated on the frequency display.

31 **BAND WIDTH** switch
Selects the IF bandwidth. The frequency resolution is determined by this IF bandwidth.

32 **VIDEO FILTER** switch
When this switch is set to **ON**, L.P.F. (Low Pass Filter) of the CRT drive section is inserted which smoothes out the noise to improve S/N.

33 **WARNING** lamp
If this lamp lights, it means that the level displayed on the CRT display is not accurate. Adjust the **BAND WIDTH, SCAN TIME/DIV.** and **DISPERSION/DIV.** switches so that this lamp is not lit.

34 CRT display
A square cathode-ray tube having a 10 cm x 8 cm display area. P7 phosphor is used.

35 **PHONE** connector
This jack is used when monitoring the modulated frequency with the **DISPERSION/DIV.** switch set to "0".

36 **TRACKING GENERATOR OUTPUT** connector
Outputs the tracking generator signal. The output impedance is 50 Ω.

37 **OUTPUT LEVEL (dBm)** switch
Sets the output level of the tracking generator from 0 dBm to –50 dBm in 10 dB steps.

38 **T.G. MODE** switch
When this switch is set to **NORMAL**, the instrument operates as a tracking generator and at the position of **TUNED AMP.** the instrument operates as a selective amplifier (tuned amplifier).

39 **COUNTER POWER** switch
When this switch is pushed **ON**, power is supplied to the counter section for operation.

40 **RESOLUTION** switch
Selects **100 Hz** or **1 kHz** frequency resolution of counter.

41 Frequency counter
Displays the frequency of the bright point on the CRT. The display is by 8-digit LED in the unit of "MHz".

REAR PANEL

42 GND terminal
Ground terminal of the instrument. When the two-pin adaptor is used with the power cable, either the lead of the adaptor or this terminal must be grounded.

43 **POWER MODE** switch
Selects the power source to drive the instrument. The instrument is operated on the AC power line when push button is pressed in. Push button must be depressed and released a second time to supply DC power source to the instrument.

44 AC power cable
This is used to connect the instrument to the AC line.

45 Fuse holder
To change the fuse, remove the cap of the holder by turning it in the direction of the arrow.

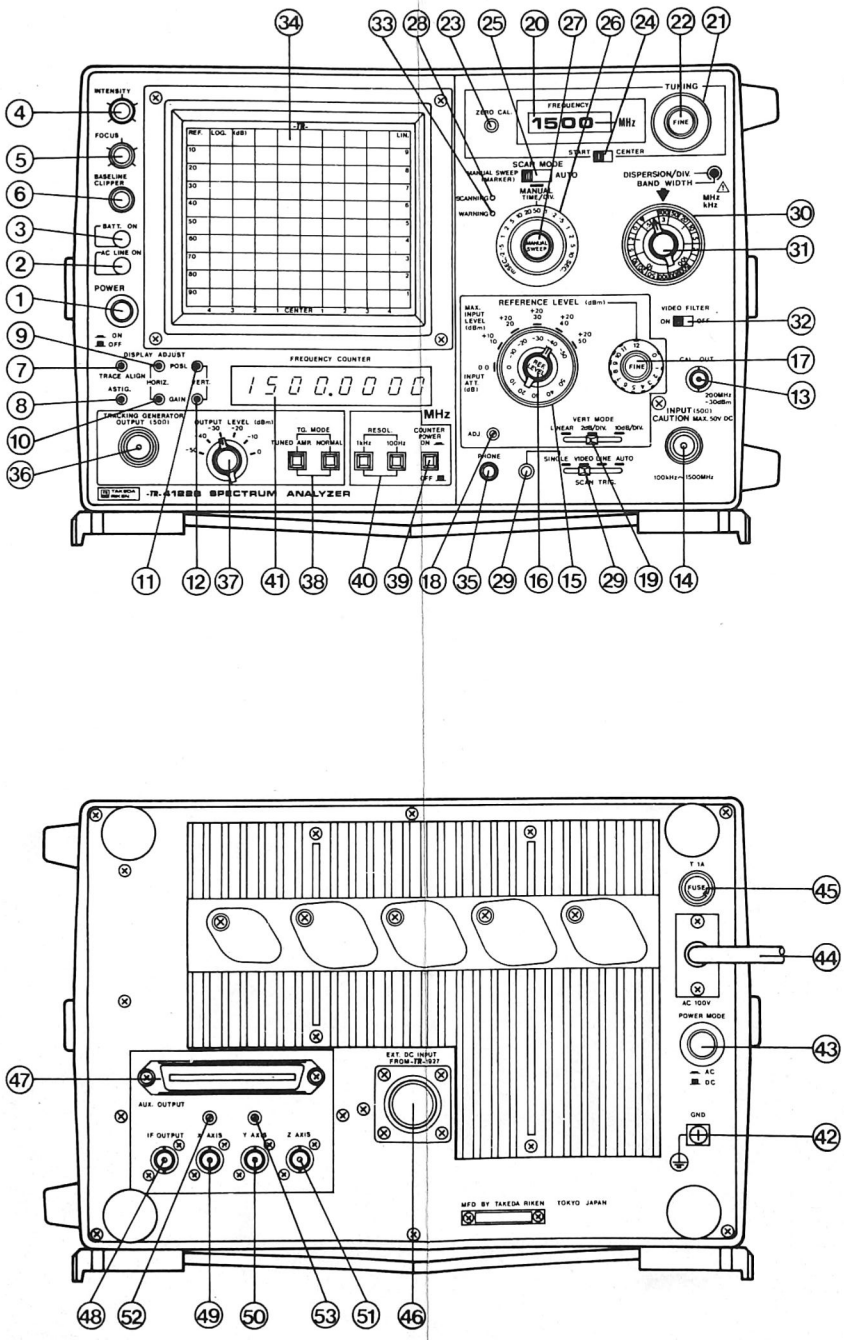


Fig. 2-2 Panel Description

CAUTION

Disconnect the power cable from the AC socket before changing the fuse.

46 **EXT. DC INPUT** connector
Connects the instrument to the ***-TR-1927*** DC Power Supply.

47 **AUX. OUTPUT** connector
A 50-pin connector used to fit the instrument with an external counter or other device.

48 **IF OUTPUT** connector
The 10.7 MHz IF output signal is output from this connector.

49 **X-AXIS** connector
X-axis output connector. The output is about −5 V to +5 V with an output impedance of approximately 1 kΩ.

50 **Y-AXIS** connector
Y-axis output connector. The output is about 0 V to +5 V with an output impedance of approximately 10 kΩ.

51 **Z-AXIS** connector
Z-axis output connector. It is used for blanking. The Hi output is +15 V and Lo is 0 V. Blanking is applied when the output is at Lo level.

52 X-axis output voltage control
Controls the output voltage of approximately ±1.2 V to ±5 V.

53 Y-axis output voltage control
Controls the output voltage of approximately +1.3 V to +5 V.

2-4 Basic Operation

The operations described here may also be used to check whether the instrument is operating normally.

Refer to [Fig. 2-3].

1. Confirm that the **AC** line voltage is the same as the voltage given on the rear panel.
2. Make sure that the **POWER MODE** switch on the rear is set to **AC** and the front panel **POWER** switch is set to **OFF**. Next connect the power cable to the **AC** line.
3. Set the front panel switches as follows:
   INTENSITY ..... Center
   FOCUS ..... Center
   BASELINE CLIPPER ..... Fully counterclockwise
   TUNING ..... **0000 MHz**
   START/CENTER ..... **CENTER**
   SCAN MODE ..... **MANUAL**
   TIME/DIV. ..... **5 ms/DIV.**
   DISPERSION/DIV. ..... **100 MHz/DIV.**
   BAND WIDTH ..... **3 MHz**
   VIDEO FILTER ..... **OFF**
   INPUT ATT. (RF ATT.) ..... **10 dB**
   REFERENCE LEVEL ..... **0 dB**
   REFERENCE LEVEL-FINE ..... **0 dB**
   VERT. MODE ..... **10 dB/DIV.**
   SCAN TRIG. ..... **AUTO**
   COUNTER POWER ..... **OFF**
4. Set the **POWER** switch to **ON**. The **AC LINE ON** lamp lights and the **SCANNING** lamp begins to flash. Approximately 20 seconds later a zero frequency spectrum trace will appear on the CRT.
5. If the trace fails to appear, turn the **INTENSITY** control clockwise to increase the brightness. If the trace is too bright, adjust it by turning the **INTENSITY** control counterclockwise.

CAUTION

Note that the CRT display will be burned if the trace is too bright.

6. When the trace is not adequately focused adjust the **FOCUS** control to obtain a clear and crisp line. If the trace is too bright, clear focus will not be obtained, so it is necessary to adjust the brightness.
7. Set the **VERT MODE** switch to **LINEAR**.

8. If the trace is tilted relative to the horizontal scale of the CRT display, adjust it with the **TRACE ALIGN** control.
9. After adjusting the horizontal angle of the trace, set the **VERT. MODE** switch to **10 dB/DIV.**
10. Set the **START/CENTER** switch to **START** and check that the zero frequency appears at the left end of the CRT display.
11. Set the front panel switches as follows:
    FINE TUNING . . . . . Center
    SCAN MODE . . . . . **AUTO**
    START/CENTER . . . . . **CENTER**
12. See that the frequency display is 0000 MHz. Adjust the **ZERO CAL.** control to position the zero frequency at the center of the CRT display.

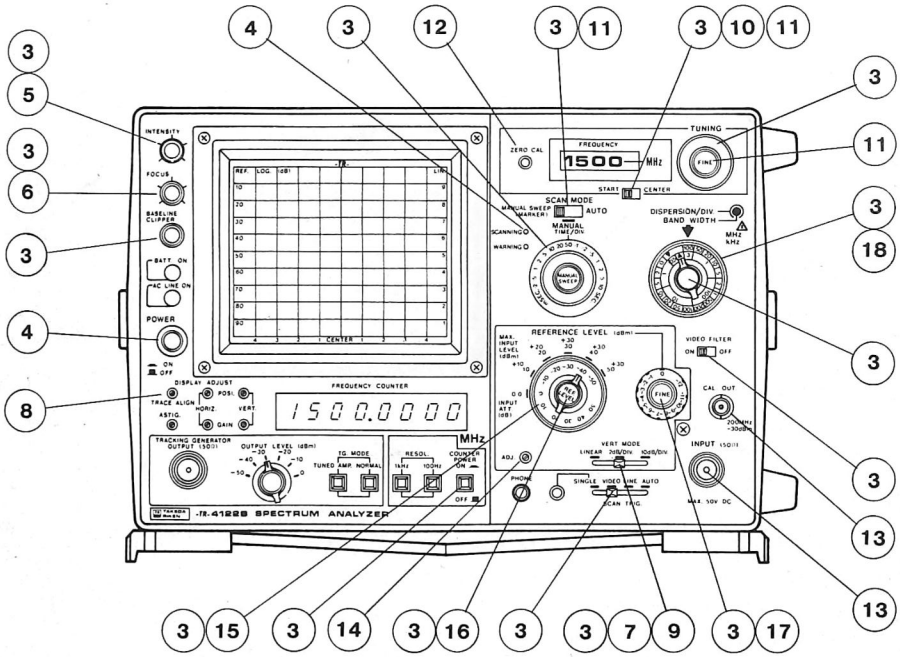


Fig. 2-3 Controls for Basic Operation

13. Fit an N-BNC adaptor to the accessory BNC-BNC cable (**MC-61**), and connect the **CAL. OUT.** terminal to the **INPUT** with this cable. [Fig. 2-4] The spectrum shown in [Fig. 2-5] will appear on the CRT display at this time.
14. Check that the 200 MHz fundamental spectrum is positioned on the scale of 3 div. from top (–30 dBm) on the CRT display. If not, adjust with the **ADJ.** control. The spectrum also appears to the left of the zero frequency spectrum, but the level and frequency of this spectrum are not correct.
15. Turn the **INPUT ATT.** control clockwise and check that the **CAL. OUT.** signal drops in 10 dB steps. The zero frequency level and noise do not change at this time.
16. Turn the IF GAIN control clockwise. The spectrum on the CRT display goes upward in 10 dB steps followed by the noise level. As IF GAIN control is turned counterclockwise, the spectrum and noise levels drop.
17. Turn the **FINE** control clockwise from the full counterclockwise position and check that the level changes 10 dB or more.
18. Turn the **DISPERSION/DIV.** switch counterclockwise and see that the spectrum is expanded.

2-5 Function and Operation on the Panel

1. The **DISPERSION/DIV.** switch is used when it is desired to expand and observe an arbitrary signal spectrum. Expansion can be effected either at left and right from the center of the CRT display or at the left end (start point) of the CRT by operation of the **START/CENTER** switch, when the spectrum is positioned by the **TUNING** control either in the center or at the left end.

   When turning the **DISPERSION/DIV.** switch counterclockwise, the spectrum can be expanded.

   If the spectrum shifts simultaneously with expansion, readjust the **TUNING** control. [Fig. 2-6]

   If the **DISPERSION/DIV.** switch is set to "**0**", the instrument operates as a tuned receiver. It can be used to demodulate and observe a modulated signal or to monitor a single signal.

   When pulled forward, the switch can operate independent of the **BAND WIDTH** switch. When pushed backward, it is operated simultaneously with the **BAND WIDTH** switch. When operated with the **BAND WIDTH** switch, the triangular mark (▼) position is optimum for spectrum analysis. So it is suggested to keep this position for normal use.

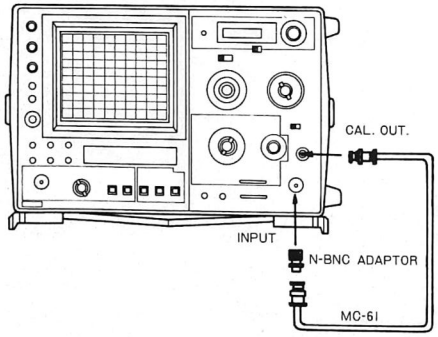


Fig. 2-4 CAL. OUT. Signal Connection

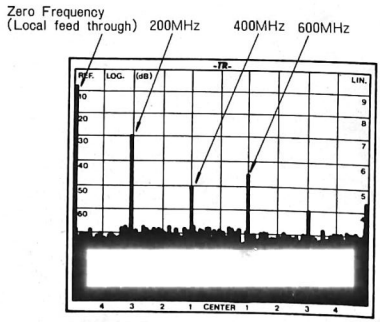


Fig. 2-5 CAL. OUT. Signal Spectrum Display

If the **SCAN MODE** switch is set to **AUTO** under this state, the optimum scan speed (**TIME/DIV.**) is automatically selected depending on position of the **DISPERSION/DIV., BAND WIDTH**, and **VIDEO FILTER** switches.

When used with the **DISPERSION/DIV.** set to "**0**", **SCAN TIME** must be at **MANUAL** and the **BAND WIDTH** must be independent from the **DISPERSION/DIV.**

2. There is a dual tuning dial, one is for course tuning and the other for fine tuning. The smaller one is the fine tuning control to adjust more than 2 MHz for 10 turns. Therefore, it is convenient when the **DISPERSION/DIV.** switch is used at **200 kHz/DIV.** or below.
3. Setting of the **BAND WIDTH** (IF bandwidth) switch determines the frequency resolution. If the narrowest IF bandwidth is 1 kHz, for example, two signals cannot be separated unless more than 1 kHz away each other. [Fig. 2-7] Therefore, the time constant is longer as the IF bandwidth is narrower, and so the **TIME/DIV.** value must be larger.
4. The IF bandwidth is generally stipulated at the 3 dB bandwidth. A filter has selectivity to characterise the filter, which is specified by the ratio of the 60 dB bandwidth and 3 dB bandwidth.

   Therefore, good selectivity means an improved ability to discriminate signals of different amplitudes. When the IF bandwidth selectivity is 5:1, to observe two signals having a difference in amplitude of 60 dB by separating them completely, the frequency difference of the two signals must be 2.5 times or more the IF bandwidth.

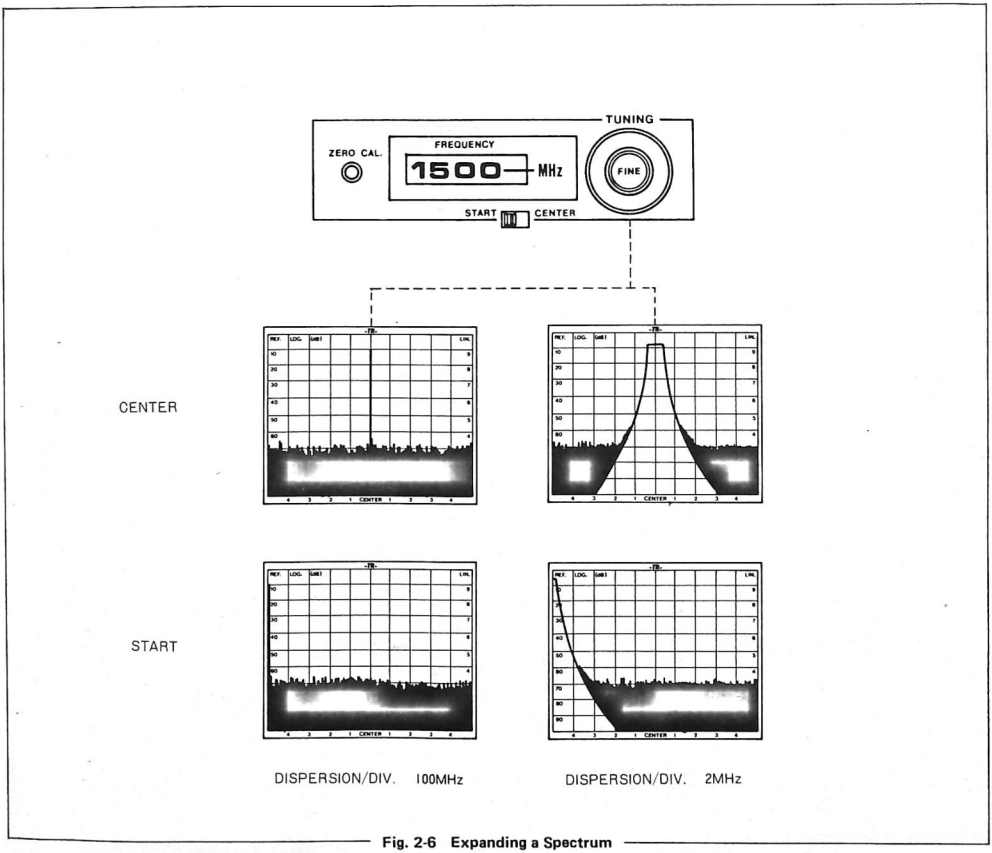


Fig. 2-6 Expanding a Spectrum

5. The ability to separate signals of different amplitudes and adjacent frequencies is the noise side band plus the IF bandwidth selectivity. The noise side band is what appears at the skirt of an IF filter as shown in [Fig. 2-8] and disturbs resolution when observing frequencies. The noise side band of this instrument is less than –70 dB at 20 kHz away from the carrier (IF bandwidth 1 kHz, video filter ON).
6. The **VIDEO FILTER** is used when observing the signal, with improved resolution at the skirt of the IF filter and lower part of the spectrum. The **VIDEO FILTER** integrates the noise by inserting an L.P.F. (Low Pass Filter) of 1/30 of the IF bandwidth at the CRT Drive Section. This improves the S/N about 10 dB. Depending on selection of the IF bandwidth, noise level changes as per the following table.

IF band width	VIDEO FILTER	
	OFF	ON
500 Hz	–113 dBm	–123 dBm
1 kHz	–110 dBm	–120 dBm
10 kHz	–100 dBm	–110 dBm
100 kHz	–90 dBm	–100 dBm
1 MHz	–80 dBm	–90 dBm
3 MHz	–75 dBm	–85 dBm

Therefore, a narrower IF bandwidth (narrow **BAND WIDTH** value) is selected with the **VIDEO FILTER ON** to observe low level signals.

7. **INPUT ATT.** is first set at the high value and then low value when the input signal level is unknown.
8. When measuring harmonic distortion and spurious response, careful attention must be given to the harmonic distortion generated in the internal mixer.
   As shown in [Fig. 2-9], when the input of –30 dBm is applied to the mixer, the second harmonic distortion of –70 dB, that is –100 dBm, is generated, and if the mixer input level changes 10 dB, the change of the second harmonic distortion is 20 dB. Therefore, for measurement of harmonic distortion at 60 dB or less than the input signal, the **INPUT ATT.** must be adjusted to make a mixer input level –20 dBm to –40 dBm.
9. IF GAIN is used when observing a low level spectrum. When this switch is rotated clockwise, the signal on the CRT display is raised in 10 dB steps. The noise level increases accordingly.
10. The noise at the bottom of the display can be extinguished with the **BASELINE CLIPPER** switch.

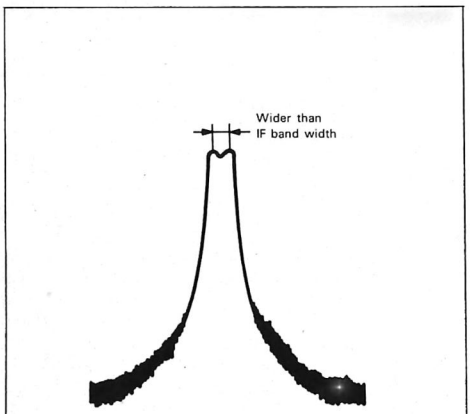


Fig. 2-7 Isolating Capability of Signals in the Same Amplitude

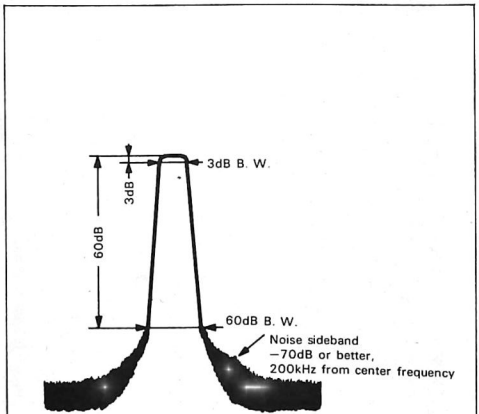


Fig. 2-8 Isolating Capability of Signals in Different Amplitudes

11. **FINE** control can continuously adjust the level of IF gain from 0 dB to −12 dB to cover 10 dB steps of IF GAIN.
By adjusting IF GAIN and **FINE** controls to position the reference spectrum at a top reference level, observation of other spectrum becomes quite easy.
12. The reference level is decided by the setting of **INPUT ATT.** and IF GAIN, which is normally read as the sum of the settings of these two controls. However, this instrument is designed so that the level can be read directly on the **REF. LEVEL** setting.
If **INPUT ATT.** is set to **10 dB** and IF GAIN to **+10 dB. REF. LEVEL** reads **0 dBm** which is the value of the reference level. If **REF. LEVEL FINE** control is operated, the value of the setting must be added.
For example, if the IF GAIN and **REF. LEVEL-FINE** controls are set as shown in [Fig. 2-10], the reference level is (−20 dBm) + (−4 dBm) = −24 dBm and the top line of the CRT display graticule is now set to −24 dBm.
The absolute value of each signal level can be read in reference to this value.

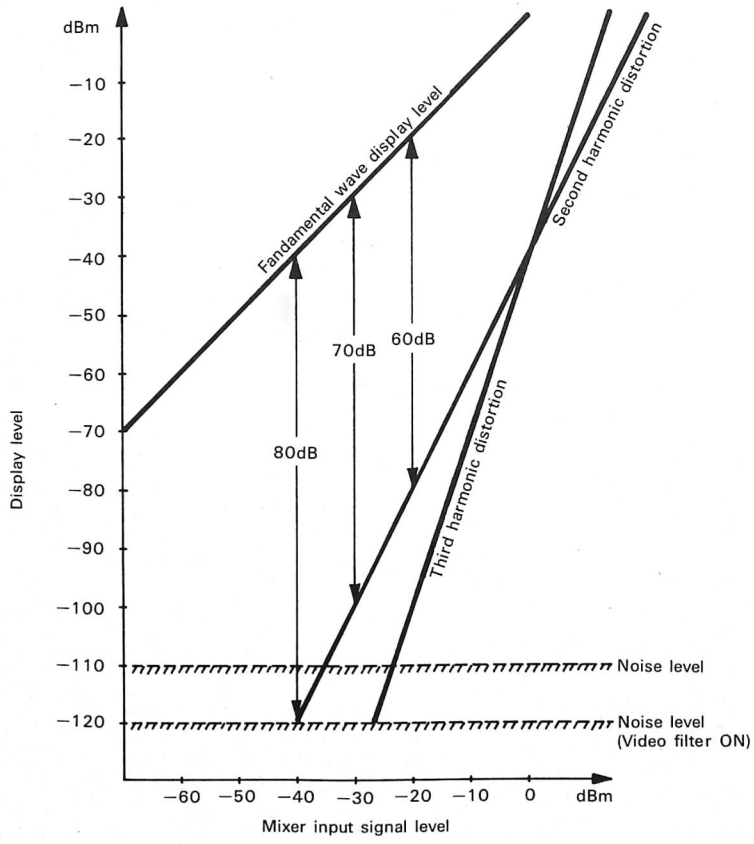


Fig. 2-9 Harmonic Distortion of Mixer at 1 kHz IF Bandwidth

13. When the **VERT. MODE** switch is set to **10 dB/DIV.**, one division of the CRT display becomes 10 dB, and if it is set to **2 dB/DIV.**, one division is expanded to 2 dB with reference to the top division of the CRT. When the **VERT. MODE** switch is turned to **LINEAR**, the signal at −7 dBm at the setting of **10 dB/DIV.** comes to the top. [Fig. 2-11] As −7 dBm = 100 mVrms in the 50 Ω system, this not only makes reading of the voltage value easier but also allows checking of small signal changes and AM modulation convenient in the **LINEAR** mode.

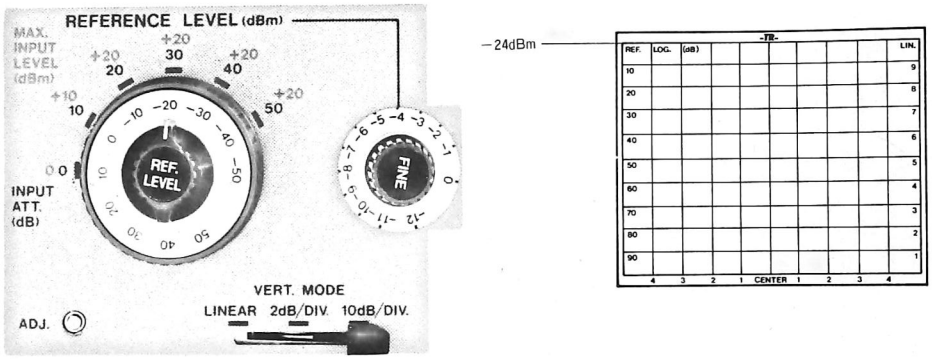


Fig. 2-10 Reading of Reference Level

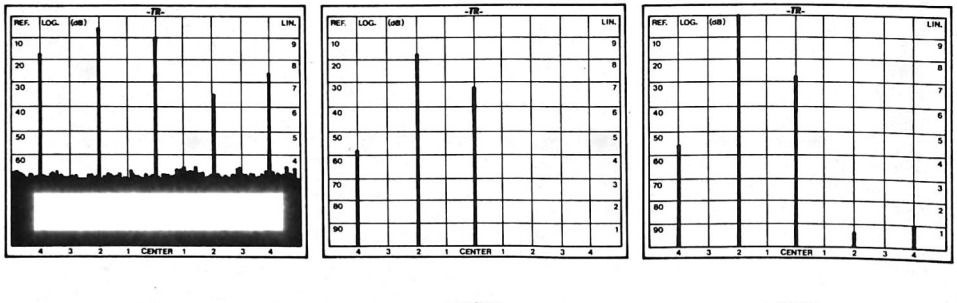


Fig. 2-11 Display by VERT. MODE switchings

2-6 Tracking Generator (T.G.)

The tracking generator (T.G.) generates a frequency signal by correctly tracking the sweep frequency of the spectrum analyzer. The instrument is effective for the precise measurement of a frequency requiring high selectivity and sensitivity as well as the measurement of resonance characteristics of a high quality element, frequency characteristics of a narrow-band bandpass filter, and reflection coefficient and reflection attenuation of the cable.

The operation procedure of the tracking generator is described below.

1. Set the **T.G. MODE** switch to **NORMAL**, and connect the signal input side of the Device Under Test (D.U.T.) to the **OUTPUT** terminal of the Tracking Generator and the output side to the **INPUT** terminal with the accessory cables. [Fig. 2-12]
2. When checking frequency characteristics of an amplifier or other active circuit, adjust the level by turning the **OUTPUT LEVEL** control counterclockwise to avoid saturation due to over-input in the Device Under Test.
3. Frequency characteristics of D.U.T. for a through connection are shown in [Fig. 2-13]. (The figure is an example of a bandpass filter.)
4. The frequency axis and amplitude axis are set the same as for the Spectrum Analysis.
5. Precautions
   In the measurements with a dynamic range greater than 80 dB, care must be taken to prevent leakage, and the following are suggested:
   - o Shield the cable
   - o Shield the input and output sections of the Device Under Test
6. When the **T.G. MODE** switch is set to **TUNED AMP.**, the instrument operates as a selective amplifier. The signal applied to the **INPUT** terminal is selectively amplified and is output from the T.G. output terminal. The output is the signal at the marker point specified by the **MARKER** control. The frequency can be accurately read cancelling undesired signals by the internal counter or an external counter.

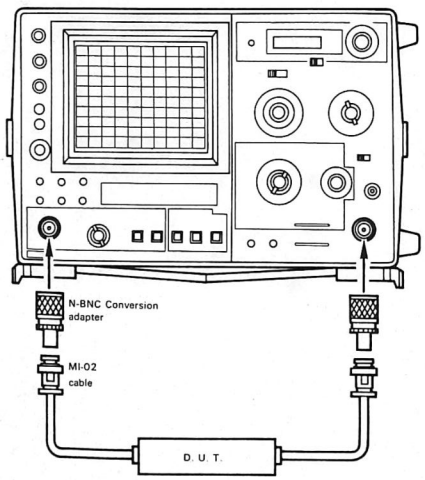


Fig. 2-12 Connection of D.U.T.

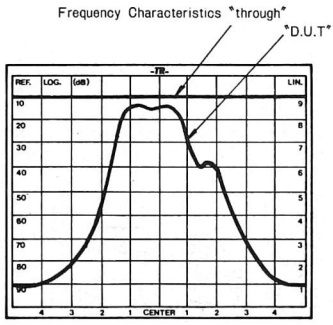


Fig. 2-13 Frequency Characteristic of a D.U.T.

2-7 Frequency Counter

The Frequency Counter built-in this instrument has a crystal oscillator stability of better than 5 x 10^{-6}/month and can be used between 400 kHz and 1500 MHz in conjunction with the Spectrum Analyzer.

1. Combination use of T.G. and Frequency Counter
   (1) Set the **COUNTER POWER** switch to **ON**.
   (2) Connect the D.U.T. and set the switches as described in para. 2-6.
   (3) The frequency characteristic and marker point will appear on the CRT display. [Fig. 2-14] The frequency of the marker point is measured.
   (4) The marker point can be moved with the **MANUAL SWEEP** control of the Spectrum Analyzer section.
   (5) The **RESOL.** switch selects the resolution of the Frequency Counter, which must be set either to **100 Hz** or **1 kHz**. Since this is also related to the intensity of the marker, pay careful attention to the sweep time.
2. Combination use of Spectrum Analyzer and Frequency Counter
   (1) Set the **T.G. MODE** switch to **TUNED AMP.**
   (2) Connect the unknown signal to the **INPUT** terminal and perform spectrum analysis.
   (3) The frequency can be measured and displayed on the Frequency Counter by setting the marker with the **MANUAL SWEEP** control to the point to be measured.
3. Precaution
   The frequency is counted normally at a position more than 15 dB above the noise level peak when the **VIDEO FILTER** is **OFF**.

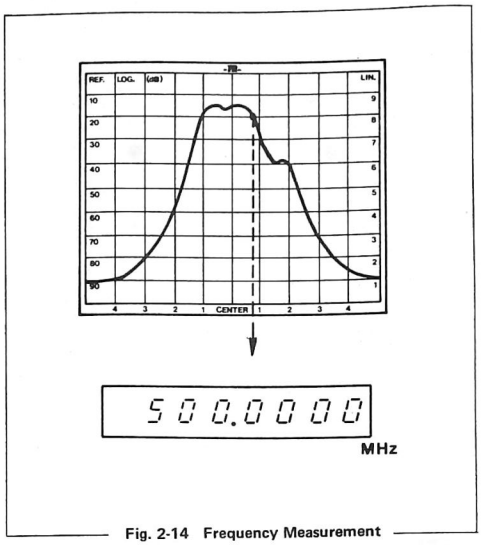


Fig. 2-14 Frequency Measurement

2-8 AUX. OUTPUT Connector Explanation.

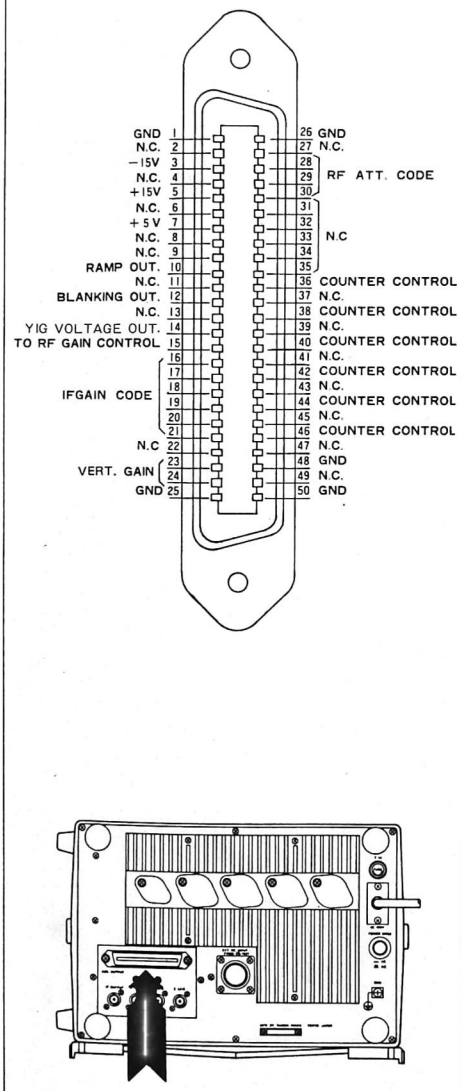


Fig. 2-15 AUX. OUTPUT Connector

Refer to [Fig. 2-15]

Pin No.	Signal
1, 25, 26, 48, 50	Ground
3 5 7	−15V +15V +5V DC voltage output from mainframe
10	Ramp output +6V −6V
13	Blanking output +5V 0V
14	YIG voltage output. The operating freguency of the YIG can be known by this voltage. 1500MHz———9.8V (Typ.) 0MHz———5.6V (Typ.)
15	IF GAIN can be changed by applying a voltage to this terminal. The adjusted range is approximately 0dB to 27.5dB with a driving voltage of 0V to 3V. The maximum impressed voltage is approximately 5V.
16, 17, 18, 19, 20, 21	Output signal when IF GAIN is selected. (V)

	0dB	10dB	20dB	30dB	40dB	50dB
16	+15	−15	−15	−15	−15	−15
17	−15	+15	−15	−15	−15	−15
18	−15	−15	+15	−15	−15	−15
19	−15	−15	−15	+15	−15	−15
20	−5.6	−5.6	−5.6	−5.6	+15	−1.4
21	−5.6	−5.6	−5.6	−5.6	−1.4	+15

23	Output signal when REFERENCE LEVEL-FINE is selected. It is −15V to −8V at 0dB to −12dB.
24	Output voltage when REFERENCE LEVEL-FINE is −12dB. The output is approximately −8V.
28, 29, 30	Output signal when RF ATT. (INPUT ATT.) is selected.

	0dB	10dB	20dB	30dB	40dB	50dB
28	+4.2	0	+4.2	0	+5.2	0
29	+4.2	+4.2	0	+4.2	0	0
30	+4.2	+4.2	+4.2	0	0	0

36, 38, 40, 42 44, 46	This is the control terminal for the external counter. A dedicated cable must be used to connect an External Counter.

2-9 CRT Display Calibration

Here the calibrating procedure for the CRT display is described. Calibrate the display by adjusting the controls when the waveform is distorted or the correct value is not displayed.

Use a minus type 3 mm screwdriver for calibration and always take more than one hour for warm up. The location of the controls for calibration is shown in [Fig. 2-16]. Proceed with the calibration of the CRT display in the order indicated below.

Control No.	Function
①	TRACE ALIGN
②	ASTIGMATISM
③	HORIZONTAL POSITION
④	HORIZONTAL GAIN
⑤	VERTICAL POSITION
⑥	VERTICAL GAIN

1. Set the front panel controls and switches as follows:

   BASELINE CLIPPER ..... Full counter-clockwise
   TUNING ..... **0000 MHz**
   START/CENTER ..... **CENTER**
   SCAN MODE ..... **MANUAL**
   TIME/DIV. ..... **5 ms/DIV.**
   DISPERSION/DIV. ..... **100 MHz/DIV.**
   BAND WIDTH ..... **3 MHz**
   VIDEO FILTER ..... **OFF**
   INPUT ATT. (RF ATT.) ..... **0 dB**
   REFERENCE LEVEL-FINE ..... **0 dB**
   VERT. MODE ..... **10 dB/DIV.**
   SCAN TRIG. ..... **AUTO**

2. Calibration of Trace Inclination

   The **TRACE ALIGN** must be corrected when the trace is tilted because of the effect of earth's magnetism and magnetic devices.

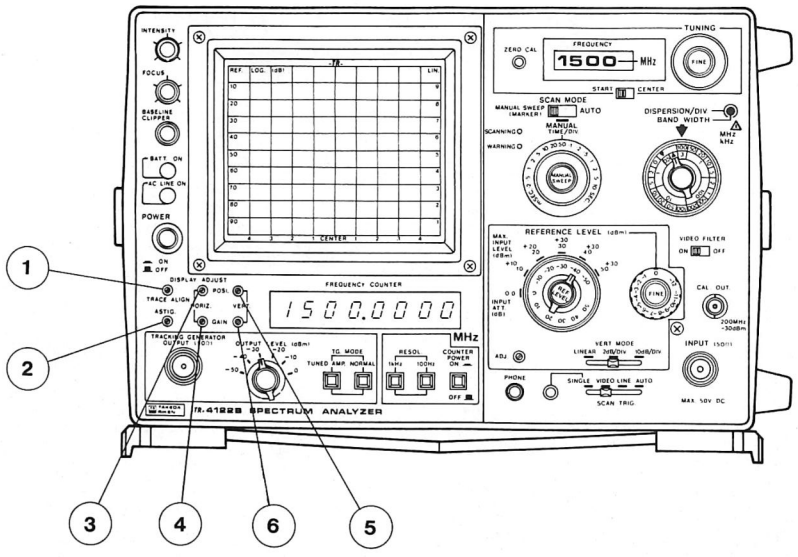


Fig. 2-16 CRT Display Calibration

After the power is put on, the trace will appear on the CRT. Adjust **TRACE ALIGN** so that the trace is parallel with the horizontal axis of the CRT graticule. If the **VERT. MODE** switch is set to **LINEAR**, a noise-free trace must appear.

3. Adjusting the Focus
   Adjust the **ASTIG.** control ② to obtain a constant focus over the entire CRT screen. This adjustment is necessary when focusing is difficult with the **FOCUS** control.
4. Adjusting horizontal position
   The **HORIZ. POSI.** is to adjust the position of the horizontal axis.
   With the **DISPERSION/DIV.** at **100 MHz/DIV.**, position the zero frequency in the center of the horizontal axis on the CRT with the **TUNING** control.
   Then use **HORIZ. POSI.** control ③ so that the position of the zero frequency does not change even when the **DISPERSION/DIV.** switch is switched to **10 MHz/DIV.** The **START/CENTER** switch is set to **CENTER** beforehand.
5. Adjusting horizontal axis scale
   Set the **DISPERSION/DIV.** switch to **100 MHz/DIV.** and apply the **CAL. OUT.** signal to the input terminal, using the accessory cable **(MC-61)** and adaptor. Set the **TIME/DIV.** switch to **10 ms/DIV.** and position the zero frequency signal to the left end of the CRT graticule with the **TUNING** control. Adjust the **HORIZ. GAIN** control ④ so that each harmonic component of the **CAL. OUT.** signal covers two divisions of the CRT vertical axis.
6. Adjusting Vertical Position
   VERT. POSI. is to adjust the position of the vertical axis.
   Set the **VERT. MODE** switch to **2 dB/DIV.** and position the trace to the bottom division of the vertical axis with the **VERT. POSI.** control ⑤.
7. Adjusting vertical axis scale
   Set the panel controls and switches as follows:

   DISPERSION/DIV. ..... 2 MHz/DIV.
   BAND WIDTH ..... 1 MHz
   TIME/DIV. ..... 10 ms/DIV.
   VERT. MODE ..... 10 dB/DIV.
   INPUT ATT. ..... 20 dB
   REFERENCE LEVEL ..... 20 dB
   START/CENTER ..... CENTER
   TUNING ..... 200 MHz

   Apply the **CAL. OUT.** signal to the **INPUT** terminal with the accessory cable **(MC-61)** and adaptor. Position the **CAL. OUT.** signal in the center of the CRT display with the **TUNING** control. Also position the **CAL. OUT.** signal level in the center of the CRT vertical axis with **IF GAIN ADJ.** control. Then adjust the **VERT. GAIN** control ⑥ so that the **CAL. OUT.** signal level changes corresponding to change of **INPUT ATT.** and **IF GAIN** control in 10 dB steps respectively.

2-10 Basic Applications

2-10-1 Level Measurement

1. Set the **VERT. MODE** switch to **10 dB/DIV.**
2. Input the **CAL. OUT.** signal (200 MHz, –30 dBm) at **INPUT** terminal and perform level calibration.
   The procedure for level calibration is described in para. 2-4 Basic Operation.
3. Apply the unknown signal to the **INPUT** terminal. Note that an excessively high input level may cause damage to the mixer, or saturation, resulting in erroneous measurement.
   RF ATT. (**INPUT ATT.**) prevents damage of mixer due to excessively large input, drop of display level due to saturation, or faulty measurement due to harmonic distortion.
   When the input signal is unknown, therefore, switching should be made from a high value to a lower one. A drop in the output level due to saturation is specified as gain compression, which should be less than –1 dB for –10 dBm input. When **INPUT ATT.** is set at **0 dB**, errors may increase due to mismatching. Particular attention should be paid on the above points to ensure measurement at a correct level.
4. Set the **START/CENTER** switch to **CENTER.**
5. Position the signal to be read in the center of the CRT display with the **TUNING** control. At this time confirm that the **WARNING** lamp is not lit.
6. When setting the **REF. LEVEL** switch as in [Fig. 2-17], assume the spectrum shown at the right side of [Fig. 2-17] is observed. The reference level at this time is (–20 dBm) + (–4 dBm) = –24 dBm which is the level at the top of the CRT display. From this, the level of the spectrum is (–24 dBm) + (–25 dBm) = –49 dBm.
   It is therefore noted that the signal is a –49 dBm signal.
   Since this value is the power indicated for a 50 Ω impedance system, the level conversion [table 3-18] can be conveniently used to convert the value in the other system.
   To convert –49 dBm to dBμ, from the table, –49 dBm = +58 dBμ.
   As this value of +58 dBμ is for 50 Ω termination, 6 dB must be added to convert it to open circuit voltage. Therefore, the open circuit voltage is (+58 dBμ) + (6 dB) = 64 dBμ.

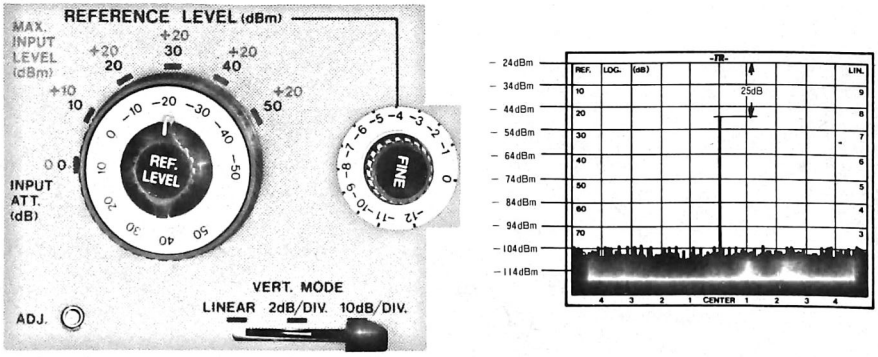
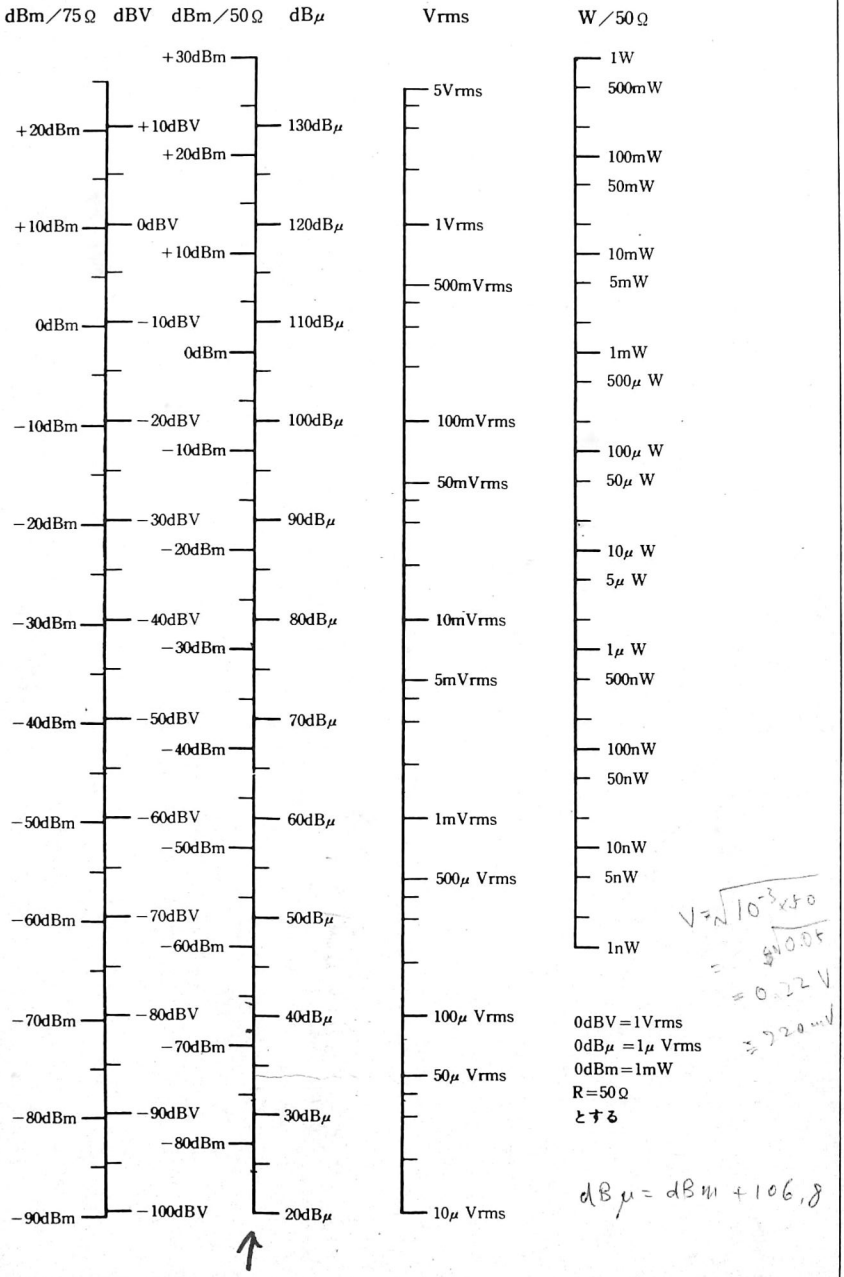


Fig. 2-17 Reading of Level

dBm／50Ω, dBm／75Ω, Vrms, W／50Ω, dBμ, dBV



0dBV＝1Vrms
0dBμ ＝1μ Vrms
0dBm＝1mW
R＝50Ω
とする

$dB\mu = dBm + 106.8$

Fig. 2-18 Level Conversion Table

2-10-2 Measurement of Electric Field Strength

The spectrum analyzer is same as a Field Strength Meter in principle. An example of field strength measurement using the **-TR-4122B** is described here.

Assume that the level measured with the spectrum analyzer is ex (dB).

Ex (dB): Field strength to be measured (1 μV/m = 0 dB)

He (dB): Effective value of dipole antenna (1 m = 0 dB)

La (dB): Cable loss

$$ex = Ex + He - La$$

$$\therefore Ex = ex + La - He$$
$$= ex + K \quad \ldots\ldots\ldots\ldots \quad (1)$$

The frequency and calibration coefficient K are given in [Fig. 2-19]. (La is included.)

With the **-TR-4122B** the field strength of the received radio wave can be found by adding the coefficient K to the measured value after conversion in dBμ.

The procedure is as follows;

1. Set the **VERT. MODE** switch to **10 dB/DIV.**
2. Apply the **CAL. OUT.** signal (200 MHz, –30 dBm) to the **INPUT** terminal and check that the reference level is correct.
3. Set the **START/CENTER** switch to **CENTER.**
4. Connect a dipole antenna to **-TR-4122B** as illustrated in [Fig. 2-20].
5. Position the signal to be observed in the center of the CRT display with the **TUNING** control.
6. If the reference level reading (top division of CRT display) is –24 dBm (refer to para. 2-10-1 "Level Measurement"), from the CRT display of [Fig. 2-21] it is known;
   Spectrum frequency . . . . . 800 MHz
   Level . . (–24 dBm) + (–40 dB) = –64 dBm

From the calibration coefficient in [Fig. 2-19], K = 29.2 dB (as this is the calibration coefficient for 50 Ω termination, the addition of 6 dB for an open circuit is not necessary.)

From [Fig. 2-18], –64 dBm = +43 dBμ, and from the (1) equation, +43 (dBμ) + 29.2 (dB) = 72.2 (dBμ/m).

This value of 72.2 dBμ/m is the field strength under measurement. When there is cable loss and cable gain, the true value is acquired as follows:

Field strength = (calculated value) + (cable loss) – (antenna gain)

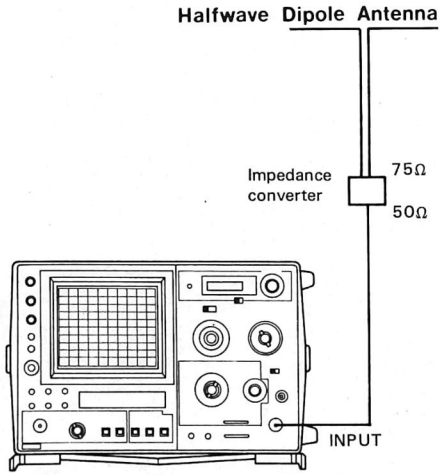


Fig. 2-20 Field Strength Measurement

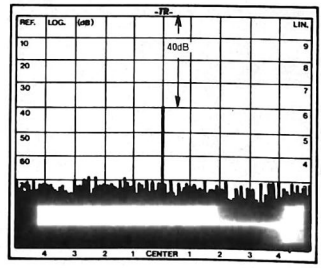


Fig. 2-21 Display of Typical Field Strength

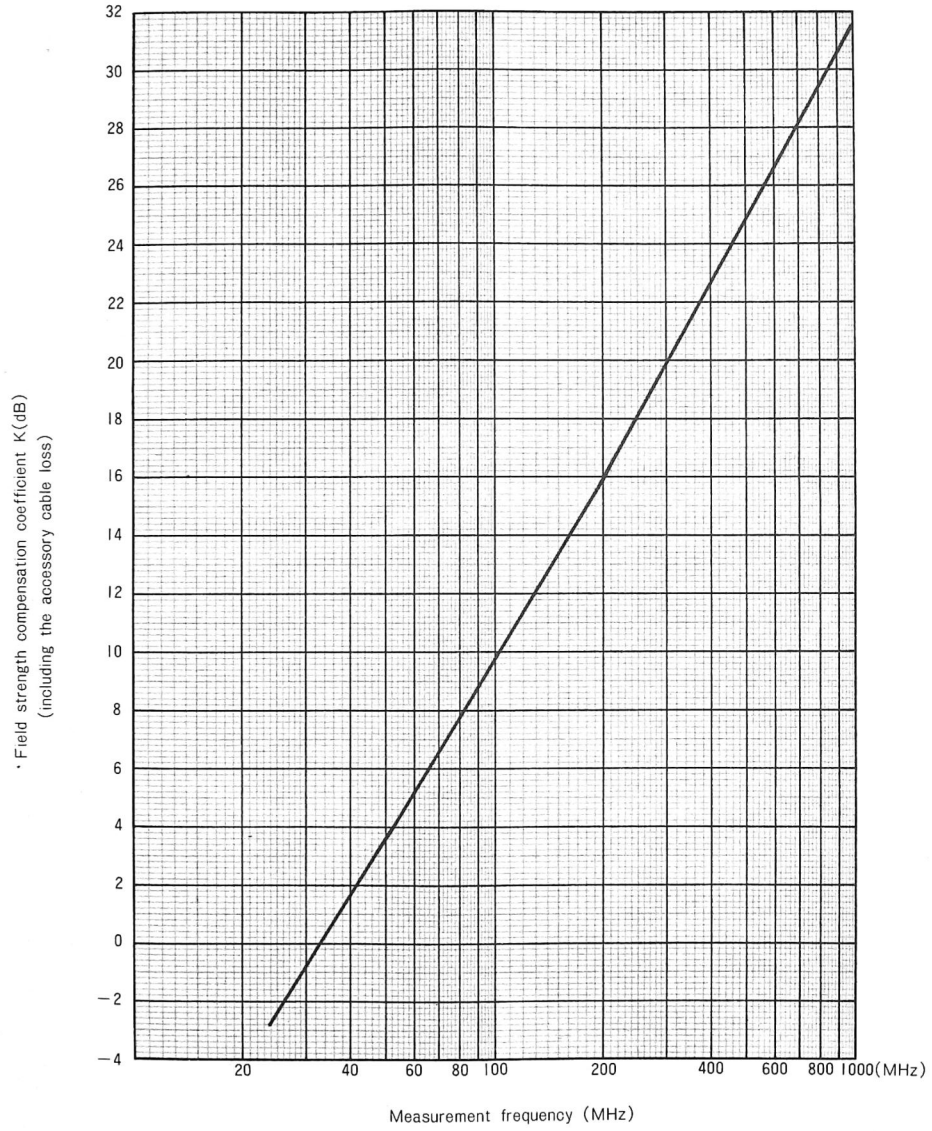


Fig. 2-19 Calibration Coefficient

2-10-3 Measurement of Wideband Modulated Signal using IF OUTPUT

The same signal as the input to the IF section is output at the **IF OUTPUT** terminal on the rear panel as shown in [Fig. 2-22].

This function is the input signal down converted to 10.7 MHz, and has effective application. For instance, highly modulated signals such as television and radar signals can be observed in modulated waveforms by applying the signal to the **INPUT** and connecting a wide band oscilloscope to the **IF OUTPUT** terminal.

The following is the procedure for a 100 MHz signal input:

1. Set the **START/CENTER** switch to **CENTER**.
2. Apply the 100 MHz signal to the **INPUT** terminal.
3. Adjust the **TUNING** control to position the 100 MHz signal in the center of the CRT display.
4. Set the **DISPERSION/DIV.** switch to "**0**". The signal down converted to 10.7 MHz is output at the **IF OUTPUT** terminal.
   In this zero scan mode (**DISPERSION/DIV.** is set at "**0**") the 1st LO in [Fig. 2-22] does not sweep, so the instrument functions as a simple receiver.
   An example of a 100 MHz burst signal is shown in [Fig. 2-23]. There is a signal loss of about 10 dB between the input and output.

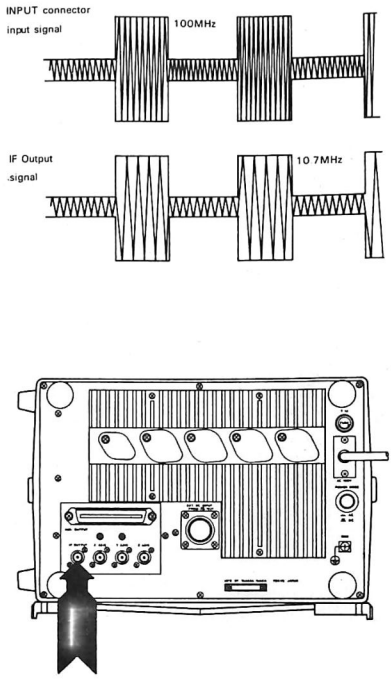


Fig. 2-23 100 MHz Burst Signal Example

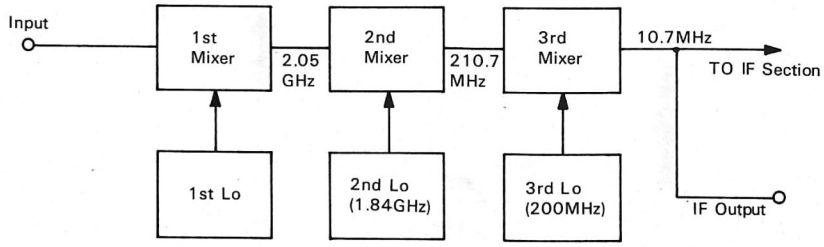


Fig. 2-22 Block Diagram of IF Output Section

2-10-4 High-sensitivity Selective Frequency Measurement

In the field of on air radio wave measurement, **-TR-4122B** can perform high-sensitivity selective frequency measurement of signals other than the carrier frequency (e.g., modulated wave, composite wave). This is impossible with the frequency counter. The carrier frequency and the frequency of each spectrum are indicated by a marker, which enables correct reading within the accuracy guaranteed by the stability of the standard oscillator of the built-in counter. The design of this instrument ensures the elimination of error when setting the marker and of differences due to the local frequency of the mainframe. Namely, by setting the mode switch of the tracking generator to **TUNED AMP.**, the tracking generator functions as a selective amplifier.

The counter is incorporated with a crystal oscillator with stability as follows:

Aging rate ..... 5×10^{-7}/month or better
Temperature coefficient ..... ±10 ppm ($0°C$ to $+40°C$)

When it is necessary to read the frequency for higher accuracy and in a larger number of digits (higher resolution), an External frequency Counter must be used. The measurement using the built-in counter has already been described in para. 2-7 "Frequency Counter". Method of using an external counter is below.

When using an external frequency counter, the **COUNTER POWER** switch is turned **OFF** to control the external counter on the -TR-4122B.

1. Applicable Counters

The Frequency Counters which can be used with this instrument are listed in [Table 2-1].

The counters, whose reference oscillator has an aging rate below 5×10^{-7}/month, are excluded from this table.

Model No.	Freguency measurement range	Connection	Connection Cable
-TR-5122Gseries	10Hz to 550MHz	Direct (**-TR-1642**)	MC-18
-TR-5123Gseries	10Hz to 1000MHz	Direct (**-TR-1642**)	MC-18
-TR-5124	10Hz to 1500MHz	Direct	MC-18
-TR-5501Gseries	DC to 250MHz	With Op. 14	MC-19
-TR-5502Gseries	DC to 250MHz	With Op. 13 or With Op. 14	MC-19
-TR-5153 series	DC to 100(1000)MHz	With Op. 13 or With Op. 14	MC-19
-TR-5840 series	0.001Hz to 100(1000)MHz	With Op. 11 or With Op. 13	MC-19
-TR-5211 series	10Hz to 18GHz	With Op. 01 or With Op. 02	MC-68
-TR-5201 series	10Hz to 18GHz	**-TR-1642**	MC-19
-TR-5202 series	10Hz to 26GHz	**-TR-1642**	MC-19
-TR-5203 series	10Hz to 32GHz	**-TR-1642**	MC-19
-TR-5204 series	10Hz to 40GHz	**-TR-1642**	MC-19

Table 2 – 1 Applicable Frequency Countres

- All of these Counters are manufactured by Takeda Riken.
- Consult your supplier when intending to use the counter which is not a Takeda Riken product.
- Do not use **-TR-5501G/5502G**series with their plug-in units.

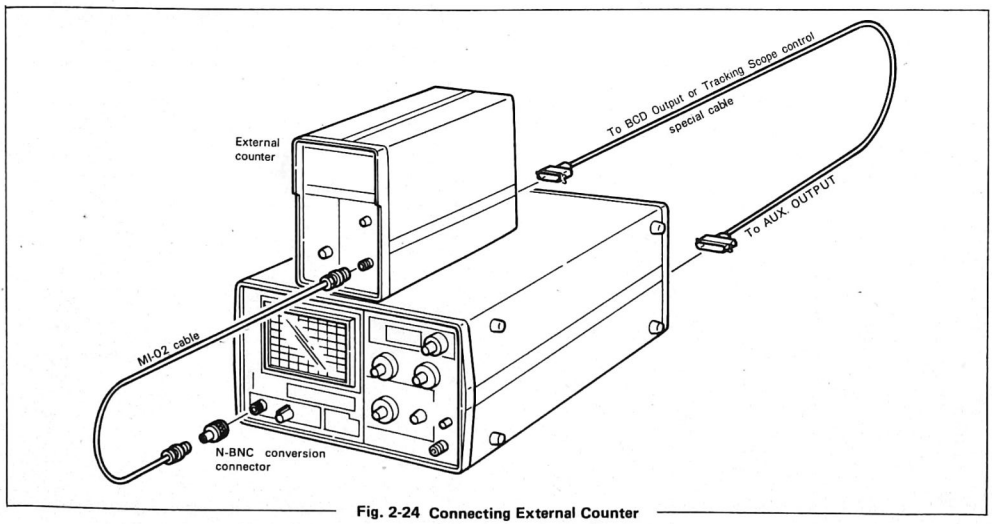


Fig. 2-24 Connecting External Counter

2. Connect the -TR-4122B and frequency Counter as illustrated in [Fig. 2-24].
   - Connect the **OUTPUT** connector of the Tracking Generator to the input of the frequency counter with the accessory cable (**MI-02** with N-BNC adaptor).
   - Connect the **AUX. OUTPUT** terminal to the output of the frequency Counter with dedicated cable (which sometimes differ depending on counters).
3. Set the **T.G. MODE** switch to **TUNED AMP.**
4. Set the external frequency Counter Gate to **HOLD.**
5. The ***-TR-*4122B** does not sweep in this state, so push the Counter **RESET** button.
6. Apply the unknown signal to the **INPUT** terminal of ***-TR-*4122B** with the accessory cable.
7. Adjust the **TUNING** control so that the signal to be observed appears on the CRT display. First set the **DISPERSION/DIV.** switch at a high value position and sequentially switch down.
8. When the level of the signal is too low to discriminate from noise, put the **VIDEO FILTER** switch to **ON** and the **BAND WIDTH** to a narrower value.
9. The marker point will appear as an intensity modulated spot on the spectrum.
   Set the marker point to the spectrum to be measured by turning the **MANUAL SWEEP** control, and the frequency of that spectrum will be displayed on the Counter.

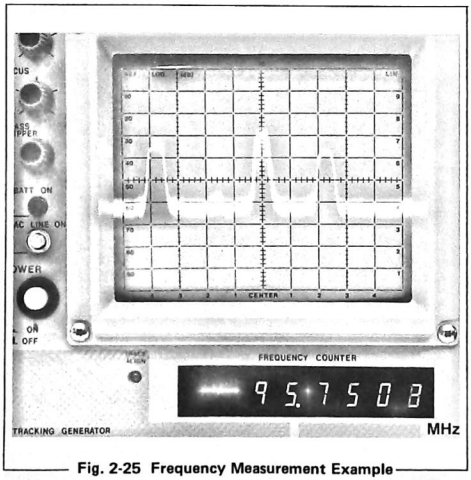


Fig. 2-25 Frequency Measurement Example

2-10-5 Return Loss Measurement

The passband characteristic of the D.U.T. (Device Under Test) can be measured easily as described in para. 2-6 "Tracking Generator." However, when power matching is a problem, the amount of reflection must be measured. The method of measuring the reflection amount, using the tracking generator, will be described here. The relationship between the reflection amount and V.S.W.R. (Voltage Standing Wave Ratio) is calculated with the following equation. This is tabulated in [Table 2-2].

$$\rho = \frac{1 + |\Gamma|}{1 - |\Gamma|} \quad \text{where } \rho : \text{V.S.W.R.}, \ \Gamma : \text{Reflection coefficient}$$

The procedure for the measurement is as follows:

1. To separate the incident wave and reflected wave, connect a directional coupler or directional bridge to the instrument, with the accessory cable as illustrated in [Fig. 2-26].
   Use all 50 Ω accessories at this time as the input impedance of the ***-TR-*4122B** is 50 Ω.
2. Set the **START/CENTER** switch to **CENTER.**
3. Adjust the frequency on the indicator to read the desired value with the **TUNING** control.
4. First, disconnect the D.U.T. to make an open or short terminal, and apply all the power at the input of the spectrum analyzer, which is displayed on the CRT display. [Fig. 2-26]
5. Adjusting the level with the **REFERENCE LEVEL** switch at this time will make later level reading convenient.
6. Next, connect the D.U.T. The power to be absorbed by the D.U.T. is absorbed, the power to be reflected is reflected, and now a waveform as in [Fig. 2-27] may be obtained. The reflected amount is less as this waveform drops lower from line ① and indicates better power matching.
7. From [Table 2-2], at the point where the waveform has dropped 20 dB from line ①, the V.S.W.R. is 1.222.

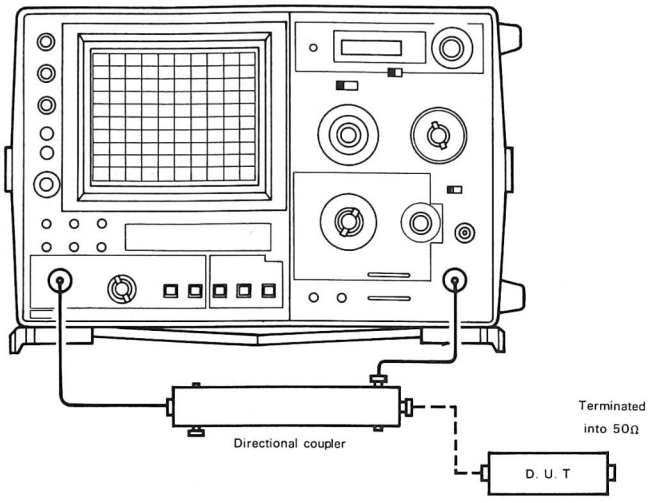


Fig. 2-26 Return Loss Measurement

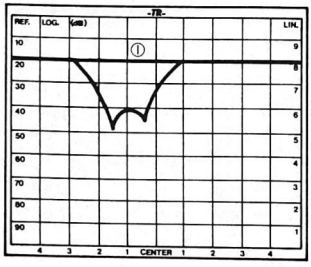


Fig. 2-27 Return Loss Measurement Example

RETURN LOSS VS.STANDING WAVE RATIO

(0.0 to 60 dB)

Return Loss (dB)	SWR	Return Loss (dB)	SWR	Return Loss (dB)	SWR	Return Loss (dB)	SWR	Return Loss (dB)	SWR	Return Loss (dB)	SWR
0.0	∞	4.4	4.033	8.8	2.140	13.2	1.560	17.6	1.304	30.0	1.065
0.1	174.4	4.5	3.947	8.9	2.120	13.3	1.552	17.7	1.300	30.5	1.061
0.2	86.72	4.6	3.864	9.0	2.100	13.4	1.544	17.8	1.296	31.0	1.058
0.3	58.00	4.7	3.786	9.1	2.081	13.5	1.536	17.9	1.292	31.5	1.055
0.4	43.44	4.8	3.710	9.2	2.061	13.6	1.528	18.0	1.288	32.0	1.051
0.5	34.78	4.9	3.639	9.3	2.043	13.7	1.520	18.1	1.284	32.5	1.048
0.6	28.98	5.0	3.569	9.4	2.025	13.8	1.513	18.2	1.280	33.0	1.046
0.7	24.84	5.1	3.503	9.5	2.008	13.9	1.506	18.3	1.277	33.5	1.043
0.8	21.73	5.2	3.440	9.6	1.990	14.0	1.498	18.4	1.273	34.0	1.041
0.9	19.32	5.3	3.379	9.7	1.973	14.1	1.491	18.5	1.270	34.5	1.038
1.0	17.40	5.4	3.320	9.8	1.957	14.2	1.484	18.6	1.266	35.0	1.036
1.1	15.81	5.5	3.263	9.9	1.941	14.3	1.478	18.7	1.263	35.5	1.034
1.2	14.50	5.6	3.209	10.0	1.925	14.4	1.471	18.8	1.259	36.0	1.032
1.3	13.39	5.7	3.156	10.1	1.910	14.5	1.464	18.9	1.256	36.5	1.030
1.4	12.43	5.8	3.106	10.2	1.894	14.6	1.458	19.0	1.253	37.0	1.029
1.5	11.61	5.9	3.057	10.3	1.880	14.7	1.451	19.1	1.249	37.5	1.027
1.6	10.89	6.0	3.010	10.4	1.865	14.8	1.445	19.2	1.246	38.0	1.026
1.7	10.25	6.1	2.964	10.5	1.851	14.9	1.439	19.3	1.243	38.5	1.024
1.8	9.684	6.2	2.920	10.6	1.837	15.0	1.432	19.4	1.240	39.0	1.023
1.9	9.178	6.3	2.877	10.7	1.824	15.1	1.426	19.5	1.237	39.5	1.0214
2.0	8.723	6.4	2.836	10.8	1.810	15.2	1.421	19.6	1.234	40.0	1.020
2.1	8.311	6.5	2.796	10.9	1.798	15.3	1.415	19.7	1.231	41.0	1.018
2.2	7.936	6.6	2.757	11.0	1.785	15.4	1.409	19.8	1.228	42.0	1.016
2.3	7.598	6.7	2.720	11.1	1.772	15.5	1.404	19.9	1.225	43.0	1.014
2.4	7.285	6.8	2.684	11.2	1.760	15.6	1.398	20.0	1.222	44.0	1.013
2.5	6.997	6.9	2.649	11.3	1.748	15.7	1.393	20.5	1.208	45.0	1.011
2.6	6.731	7.0	2.615	11.4	1.737	15.8	1.387	21.0	1.196	46.0	1.010
2.7	6.485	7.1	2.582	11.5	1.725	15.9	1.382	21.5	1.184	47.0	1.009
2.8	6.257	7.2	2.549	11.6	1.714	16.0	1.377	22.0	1.172	48.0	1.008
2.9	6.045	7.3	2.518	11.7	1.703	16.1	1.372	22.5	1.162	49.0	1.007
3.0	5.847	7.4	2.488	11.8	1.692	16.2	1.366	23.0	1.152	50.0	1.006
3.1	5.662	7.5	2.458	11.9	1.681	16.3	1.362	23.5	1.143	51.0	1.0056
3.2	5.489	7.6	2.430	12.0	1.671	16.4	1.357	24.0	1.135	52.0	1.0050
3.3	5.327	7.7	2.402	12.1	1.661	16.5	1.352	24.5	1.127	53.0	1.0044
3.4	5.175	7.8	2.375	12.2	1.651	16.6	1.347	25.0	1.119	54.0	1.0040
3.5	5.030	7.9	2.348	12.3	1.641	16.7	1.342	25.5	1.112	55.0	1.0036
3.6	4.894	8.0	2.323	12.4	1.631	16.8	1.338	26.0	1.105	56.0	1.0032
3.7	4.765	8.1	2.298	12.5	1.622	16.9	1.333	26.5	1.099	57.0	1.0028
3.8	4.645	8.2	2.273	12.6	1.612	17.0	1.329	27.0	1.094	58.0	1.0026
3.9	4.529	8.3	2.250	12.7	1.603	17.1	1.324	27.5	1.088	59.0	1.0022
4.0	4.420	8.4	2.227	12.8	1.594	17.2	1.320	28.0	1.083	60.0	1.0020
4.1	4.315	8.5	2.204	12.9	1.586	17.3	1.316	28.5	1.078		
4.2	4.216	8.6	2.182	13.0	1.577	17.4	1.312	29.0	1.074		
4.3	4.122	8.7	2.161	13.1	1.568	17.5	1.308	30.5	1.069		

Table 2 – 2 Return Loss vs. Standing Wave Ratio

CHAPTER 3
PERFORMANCE CHECK

3-1 General

This Chapter describes the procedure for the performance check of **-TR-4122B** spectrum analyzer.

Major performance can be checked by using the **CAL. OUT.** (Calibration Output) signal of the mainframe.

3-2 Preparation and General Precautions

Necessary equipment and tools, and general precautions are described below. The equipment to be used must be as shown in [Table 3-1] or equivalents.

3-2-1 General Precautions

1. Always operate the instrument on AC 100 V (120 V, 200 V, 220 V, 240 V) ±10% with a line frequency of 50 Hz or 60 Hz.
2. Power cable
   The power cable has a three-pin plug, and the round center pin of this plug is a ground pin. When connecting the cable to the AC line through an adaptor, always connect the pigtail of the adaptor or the ground terminal on the rear of the instrument to earth.

Table 3-2 Tools and Jigs Necessary for Performance Test

Commodity	Stock No.	Remarks
Input cable	**MI-02**	BNC-BNC
Connection cable	**MC-37**	BNC-SMA
Connection cable	**MC-61**	BNC-BNC
Connection cable	**MM-14**	SMA-SMA
Connection cable	**MC-36**	BNC-UM
Conversion adaptor	JUG201	JUG-201A/U
Linear adaptor		UM-QA-JJ
Adaptor		HRM-501
Adaptor		HRM-508
Adjustment board	**CY-822**	22 pin, double

Table 3-1 Equipment Necessary for Performance Test

Eqeuipment	Specifications		Recommended equipment
(1) Signal generator	Frequency: Output level: Output impedance: Output level flatness: Frequency accuracy:	100 kHz to 1500 MHz +10 dBm to −30 dBm 50 Ω ±0.5 dB ±0.01%	
(2) Frequency counter	Frequency: Sensitivity: Stability:	10 Hz to 250 MHz 10 mVrms 5×10^{-8}/day	Takeda Riken **-TR-5122G**
(3) High frequency power meter	Frequency: Sensitivity: Accuracy:	100 kHz to 1500 MHz −30 dBm to +20 dBm ±0.5 dB	HP-436A
(4) Attenuator	Frequency: Attenuation: Accuracy:	DC to 500 MHz 10 dB step 0 to 100 dB 1 dB step 0 to 10 dB ±0.5 dB	
(5) Low distortion oscillator	Frequency: Output level:	5 MHz to 750 MHz −10 dBm (50 Ω)	
(6) Spectrum analyzer	Frequency:	400 kHz to 1500 MHz	Takeda Riken

3. Always confirm that the **POWER** switch is set to **OFF** before connecting the power cable to the AC line.
4. This instrument does not have a cooling fan. Be sure to keep good ventilation around the instrument. Never place other articles close to the instrument or operate with the CRT at the top.
5. Operating temperature range is 0°C to +40°C, and humidity range should be below 80%.
6. Before the performance check, warm up the instrument for about one hour.

3-3 Performance Check using CAL. OUT. Signal

The procedure to check the major performance of the instrument using the **CAL. OUT.** signal is described. Also described is the check procedure using the tracking generator and frequency counter incorporated in this instrument.

3-3-1 Preliminary Control Setting

1) Set the **POWER MODE** switch on the rear panel to **AC** and set the **POWER** switch on the front panel to **OFF**.
2) Connect the power cable to the AC power source of a voltage corresponding to that imprinted on the rear panel.
3) Set the front panel control as follows:

INTENSITY	Center
FOCUS	Center
BASELINE CLIPPER	Counterclockwise to limit
START/CENTER	**CENTER**
SCAN MODE	**MANUAL**
TIME/DIV.	**10 ms/DIV.**
FREQUENCY	**0 MHz**
REFERENCE LEVEL	**0 dBm**
VERT. MODE	**10 dB/DIV.**
INPUT ATT.	**0 dB**
BAND WIDTH	**3 MHz**
DISPERSION/DIV.	**200 MHz/DIV.**
VIDEO FILTER	**OFF**
SCAN TRIG.	**AUTO**
COUNTER POWER	**ON**
RESOL.	**1 kHz**
T.G. MODE	**NORMAL**

4) Set the **POWER** switch to **ON**, then the pilot lamp (**AC LINE ON**) and **FREQUENCY COUNTER** LED light up.
5) Within about 20 seconds after setting the **POWER** switch to **ON**, a trace of zero frequency appears on the CRT display. If the trace does not appear, turn the **INTENSITY** control clockwise to obtain brightness. If the trace is too bright, turn the control counter-clockwise to obtain appropriate brightness.

CAUTION

Do not turn the **INTENSITY** control excessively clockwise. Otherwise, the trace becomes too bright, possibly resulting in damage to the CRT.

6) If the trace is not focused, turn the **FOCUS** knob till a sharp focus is obtained. An excessively bright trace may fail to obtain a sharp focus. Adjust the brightness till an optimum trace is obtained.
7) If the zero frequency waveform shows any slope against the vertical axis scale of the CRT display, turn the **TRACE ALIGN** control on the front panel with a screwdriver to adjust. [Fig. 3-1.]
8) Fit N-BNC conversion adaptor to the accessory BNC-BNC cable (**MC-61**) and connect the **CAL. OUT.** connector to the **INPUT** connector on the front panel. The CRT display functions as shown in [Fig. 3-2].
9) Leave the instrument running in this condition for about one hour.

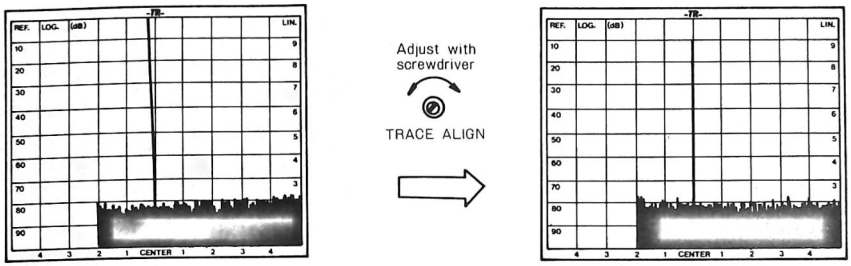


Fig. 3-1 Trace Align Adjustment

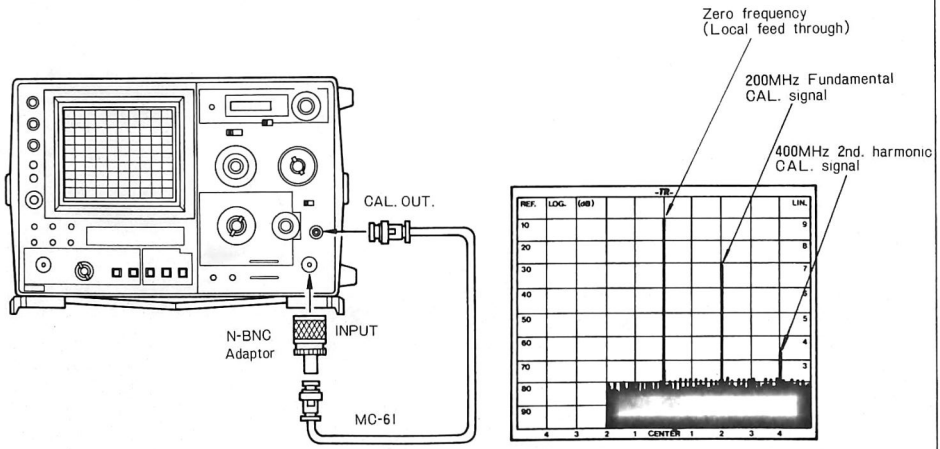


Fig. 3-2 CAL. OUT. Signal Connection and Spectrum

3-3-2 Frequency Display Accuracy Check

Specification: Within ±10 MHz

1. Change the preliminary settings as follows:
   TIME/DIV. ..... **5 ms/DIV.**
   DISPERSION/DIV. ..... **5 MHz/DIV.**
   BAND WIDTH ..... **1 MHz**
2. To obtain constant hysteresis, reset the **DISPERSION/DIV.** to **100 MHz/DIV.** and reset it again to **5 MHz/DIV.**
3. Turn the **TUNING** control till the **FREQUENCY** mechanical counter shows **0000 MHz.**
4. Turn **ZERO CAL.** control by hand till the zero frequency waveform comes to the middle of the CRT horizontal axis.
5. Turn the **TUNING** control clockwise, and read the mechanical counter when the 200 MHz CAL. signal and its harmonics are in the middle of the CRT horizontal axis. Make sure that the reading error is within ±10 MHz for 200 MHz x N (N = 1 to 8).
6. Turn the **TUNING** control counterclockwise starting from the higher frequency. Read the error according to the procedure in 5 and make sure that it is within ±10 MHz.
7. Apart from the above procedure, a check using the incorporated frequency counter is also available.
   COUNTER POWER ..... **ON**
   RESOL. ..... **1 kHz**
   T.G. MODE ..... **NORMAL**
   Turn the **MANUAL SWEEP** control till the marker point comes to the center of the CRT DISPLAY. Set 10 MHz on the mechanical counter and turn **ZERO CAL.** till the **FREQUENCY COUNTER** indicates **10.0 MHz**. Set any arbitrary value on the mechanical counter and make sure that the difference from the **FREQUENCY COUNTER** indication is within ±10 MHz.

3-3-3 Scan Linearity Check

Specification: Within ±10%

In this instrument, the YIG main coil performs sweeping for the **DISPERSION/DIV.** range from **100 MHz/DIV.** to **2 MHz/DIV.** For the range below **1 MHz/DIV.**, YIG FM coil performs sweeping. The former is called the 1st sweep and the latter the 2nd sweep.

(1) 1st Sweep Scan Linearity

1. Change the preliminary settings as follows:
   TIME/DIV. ..... **5 ms/DIV.**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **50 MHz/DIV.**
2. Turn the **TUNING** control till the zero frequency comes on the first division line from the left as shown in [Fig. 3-3].
3. Make sure that the error between 2nd harmonics of 200 MHz CAL. signal and the first division line from the right is within ±0.8 div.
4. Turn the **TUNING** control till the zero frequency comes to the center of the CRT display. When the **START/CENTER** changeover switch is set to **START**, the zero frequency comes on the left most line. Make sure that the error in this case is within ±0.4 div.

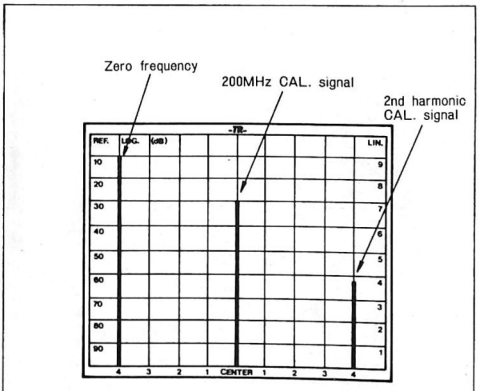


Fig. 3-3 Scan Linearity Check Procedure

(2) 2nd Sweep Scan Linearity

1. Change the preliminary settings as follows:
   TIME/DIV. ..... **5 ms/DIV.**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
2. Turn the **TUNING** control till the 200 MHz CAL. signal comes to the center (**CENTER**) of the CRT display.
3. Turn the **MANUAL SWEEP** control till the marker point comes to the center of the CRT display, and make sure that the **FREQUENCY COUNTER** shows 200.00 MHz.
4. Make sure that the **FREQUENCY COUNTER** shows 195 MHz ±500 kHz when the marker point is set to the left most line on the CRT display and 205 MHz ±500 kHz when it is set to the right most line.

3-3-4 Bandwidth Accuracy Check

Specification: Within ±20% of each resolution bandwidth

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   VERT. MODE ..... **2 dB/DIV.**
   REFERENCE LEVEL ..... **–20 dBm**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
2. Apply the CAL. signal to the **INPUT** and then turn the **REFERENCE LEVEL-FINE** control till the waveform peak of the 200 MHz CAL. signal comes on the line 3 dB (1.5 div.) distanced from the center line to the horizontal axis of the CRT display. [Fig. 3-4]
3. Make sure that the band width (3 dB) at the intersection between the waveform and the center line to the horizontal axis is within ±20% of the set band width. [Table 3-3] shows the optimum **DISPERSION/DIV.** and **TIME/DIV.** set positions.

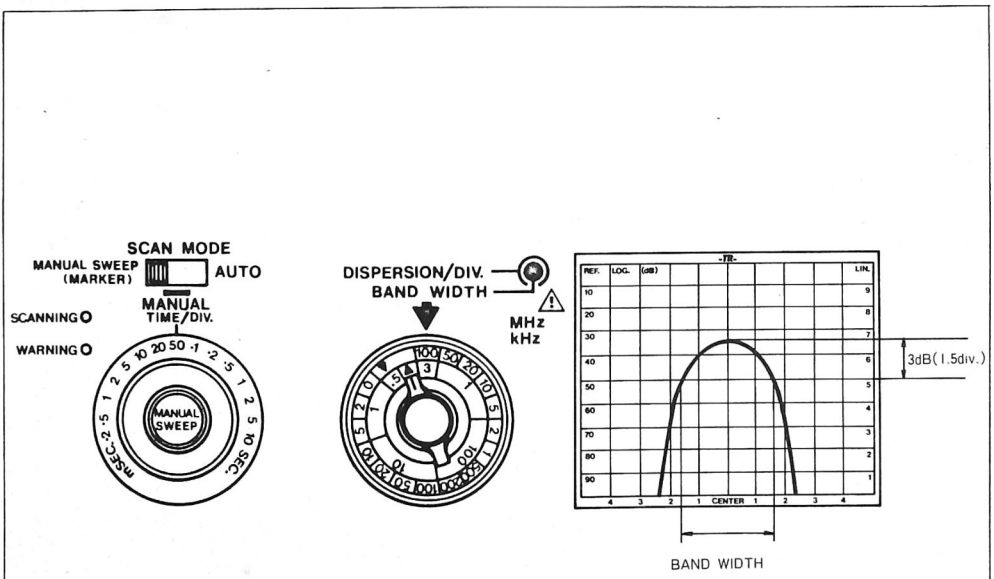


Fig. 3-4 Band Width Accuracy Check Procedure

BAND WIDTH	3MHz	1MHz	100kHz	10kHz	1kHz
± 20 %	2.4~3.6MHz	0.8~1.2MHz	80~120kHz	8~12kHz	0.8~1.2kHz
DISPERSION/DIV.	1MHz	200kHz	20kHz	2kHz	2kHz
TIME/DIV.	5ms	5ms	5ms	5ms	10ms

Table 3 – 3 Band Width Accuracy Check

3-3-5 Bandwidth Switching Level Error Check

Specification: Within ±1 dB (+20°C to +30°C)

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   TIME/DIV. ..... **5 ms/DIV.**
   VERT. MODE ..... **2 dB/DIV.**
   REFERENCE LEVEL ..... **-20 dBm**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
2. Fit the N-BNC conversion adaptor to the accessory BNC-BNC cable (**MC-61**) and connect the **CAL. OUT.** connector to the **INPUT** connector on the front panel.
3. Turn the reference level **ADJ.** control till the waveform peak of 200 MHz CAL. signal comes to the middle of the vertical axis of the CRT display. (Set the waveform peak to the **CENTER** of the horizontal axis by the **TUNING** control and **FINE** control.)
4. Change the **BAND WIDTH** sequentially while checking the level of the CAL. signal on the CRT display. Make sure that the waveform peak deviation is limited to less than 2 dBp-p. [Table 3-4] shows the **DISPERSION/DIV.** and **TIME/DIV.** set values for the **BAND WIDTH** change.

3-3-6 Average Noise Level Check

Specification: Below -85 dBm
(**BAND WIDTH** **1 MHz**, **VIDEO FILTER** **ON**)
Below -115 dBm
(**BAND WIDTH** **1 kHz**, **VIDEO FILTER** **ON**)

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   REFERENCE LEVEL ..... **-30 dBm**
   DISPERSION/DIV. ..... **2 MHz/DIV.**
   BAND WIDTH ..... **1 MHz**
   VIDEO FILTER ..... **ON**
   COUNTER POWER ..... **OFF**
   TIME/DIV. ..... **5 ms/DIV.**
2. Fit the N-BNC conversion adaptor to the accessory BNC-BNC cable (**MC-61**) and connect the **CAL. OUT.** connector to the **INPUT** connector on the front panel.
3. Turn the reference level **ADJ.** control till the waveform peak of 200 MHz CAL. signal comes on the top most line of the CRT display.
4. Make sure that the average noise level is below -85 dBm (55 dB lower than CAL. signal). [Fig. 3-5 (a)]

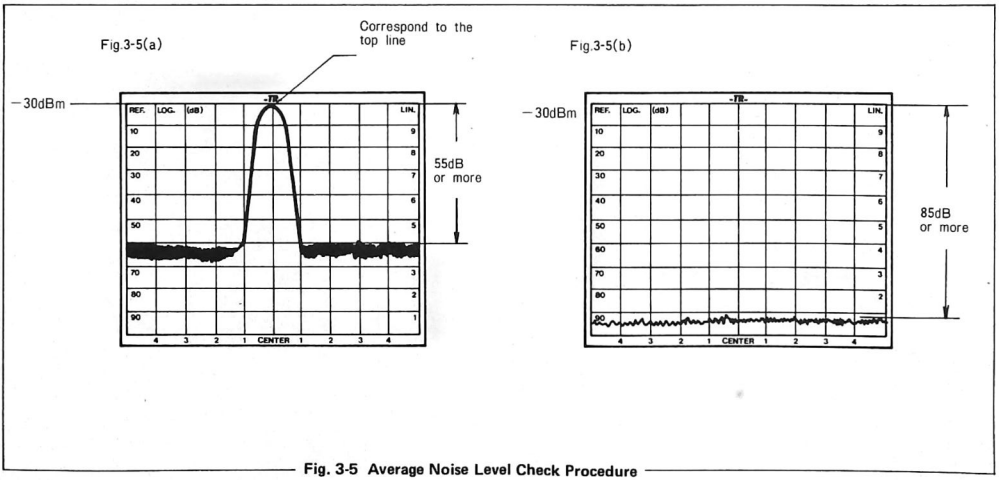


Fig. 3-5 Average Noise Level Check Procedure

BAND WIDTH	3MHz	1MHz	100kHz	10kHz	1kHz	0.5kHz
DISPERSION/DIV.	1MHz	500kHz	100kHz	10kHz	2kHz	2kHz
TIME/DIV.	5ms	5ms	5ms	5ms	10ms	10ms

Table 3 – 4 Band Width Switching Level Error Check

5. Change the settings as follows:
   BAND WIDTH ..... **1 kHz**
   DISPERSION/DIV. ..... **2 kHz/DIV.**
   TIME/DIV. ..... **0.2 s/DIV.**
6. Turn the reference level **ADJ.** control till the waveform peak of 200 MHz CAL. signal comes on the top most line of the CRT display.
7. Disconnect the CAL. signal from the **INPUT** of the mainframe. Make sure that the average noise level is below −115 dBm. [Fig. 3-5 (b)]

3-3-7 Residual Spurious Response Check

Specifications: Below −100 dBm
(No input signal, INPUT ATT. 0 dB)

1. Change the preliminary settings as follows:
   BAND WIDTH ..... **100 kHz**
   DISPERSION/DIV. ..... **2 MHz/DIV.**
   TIME/DIV. ..... **50 ms/DIV.**
   REFERENCE LEVEL ..... **−30 dBm**
   VIDEO FILTER ..... **ON**
2. Disconnect the **CAL. OUT.** connector from the **INPUT** connector.
3. Turn the **TUNING** control from 0 MHz to 1,500 MHz slowly and make sure that the response does not exceed −100 dBm.

3-4 Performance Test Using Measuring Instruments

The procedure to check the performance by using various measuring instruments is described. Also described is the check procedure using the tracking generator and frequency counter incorporated into this instrument.
Necessary equipment and tools, and general precautions are described in para. 3-2.

3-4-1 CAL. OUT. Frequency Accuracy

Specification: 200 MHz ±30 kHz
Equipment used: Built-in frequency counter

1. Fit the N-BNC conversion adaptor to the accessory BNC-BNC cable (**MC-61**) and connect the **CAL. OUT.** connector to the **INPUT** connector on the front panel.
2. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   COUNTER POWER ..... **ON**
   RESOL. ..... **100 Hz**
   T.G. MODE ..... **TUNED AMP.**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
3. Turn the **TUNING** control till the 200 MHz CAL. signal comes to the center (**CENTER**) of the horizontal axis of the CRT display.
   Turn the **MANUAL SWEEP** control till the marker point comes to the waveform peak. [Fig. 3-6]
4. Make sure that the **FREQUENCY COUNTER** reading is within 200.0000 MHz ±30 kHz.

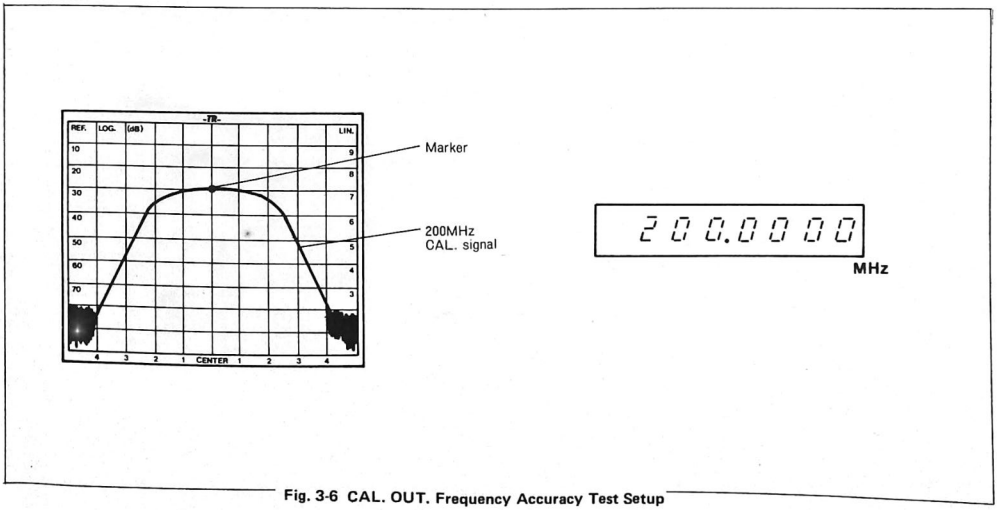


Fig. 3-6 CAL. OUT. Frequency Accuracy Test Setup

3-4-2 CAL. OUT. Level Accuracy

Specification: –30 dBm ±0.5 dB
Equipment used: High-frequency power meter
Low distortion oscillator (S.G.)

1. Change the preliminary settings as follows:
   TIME/DIV. . . . . . **10 ms/DIV.**
   REFERENCE LEVEL . . . . . **–30 dBm**
   VERT. MODE . . . . . **LINEAR**
   INPUT ATT. . . . . . **10 dB**
   BAND WIDTH . . . . . **1 MHz**
   DISPERSION/DIV. . . . . . **1 MHz/DIV.**
2. Connect the **CAL. OUT.** connector to the **INPUT** connector via an attached connection cable (**MC-61**). Turn the **TUNING** control till the 200 MHz CAL. signal comes to the center (**CENTER**) of the horizontal axis of the CRT display.
3. Turn the reference level **ADJ.** control till the waveform peak comes to the top most level (**REF.**) of the CRT display.
4. Input the 200 MHz signal from the S.G. (Signal Generator) via the same cable. Adjust the S.G. output level till the waveform peak comes to the top most line (**REF.**), the same one as described in para. 3.
5. Measure the level at S.G. output (without cable) by a power meter and make sure that it is within –30 dBm ±0.5 dB.

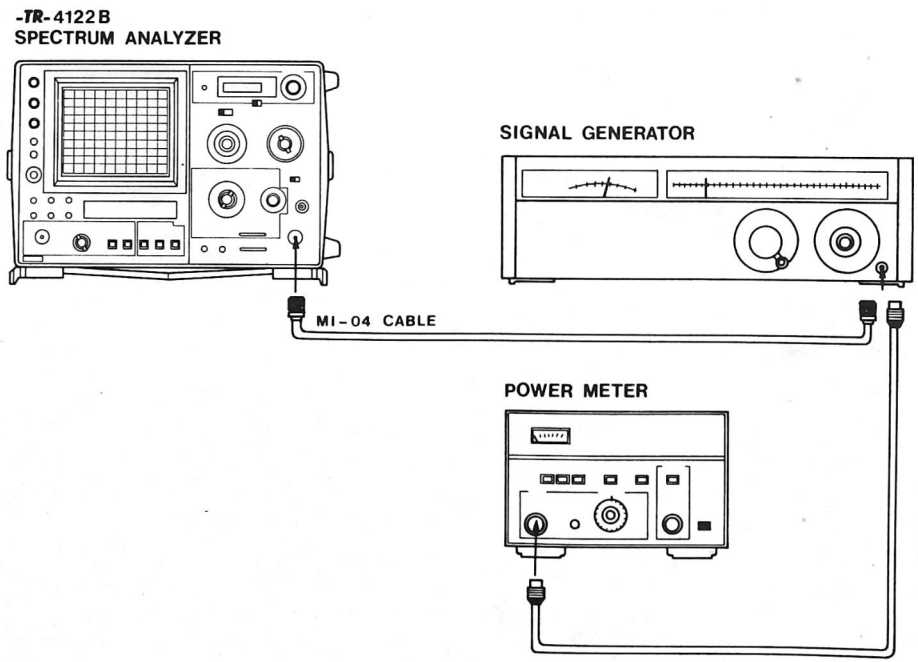


Fig. 3-7 CAL. OUT. Level Accuracy Test Setup

3-4-3 CRT LOG. Scale Accuracy "10 dB/DIV."

Specification: (Within ±1 dB/10 dB
Within ±2 dB/80 dB

Equipment used: Signal generator (S.G.)
Attenuator on 10 dB step

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   REFERENCE LEVEL ..... **−10 dBm**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **5 MHz/DIV.**
   VIDEO FILTER ..... **ON**
2. Set the S.G. output to 200 MHz and −15 dBm and set the external attenuator to 0 dB. Connect each of them to the **INPUT** of the equipment as shown in [Fig. 3-8].
3. Turn the **REFERENCE LEVEL-FINE** control till the waveform peak comes on the top most line (REF.) of the CRT display.
4. Change the external attenuator sequentially from 0 dB to 70 dB. Make sure that the display variation is within 10 dB ±1 dB for the 10 dB step of the said attenuator. [Fig. 3-9]
5. Set the **REFERENCE LEVEL** to **0 dBm** and the external attenuator to 70 dB. Make sure that the display variation is within 10 dB ±1 dB for the 10 dB step and 80 dB ±2 dB for the 80 dB step. [Fig. 3-10]

Fig. 3-9 CRT LOG. Scale Accuracy Test Display

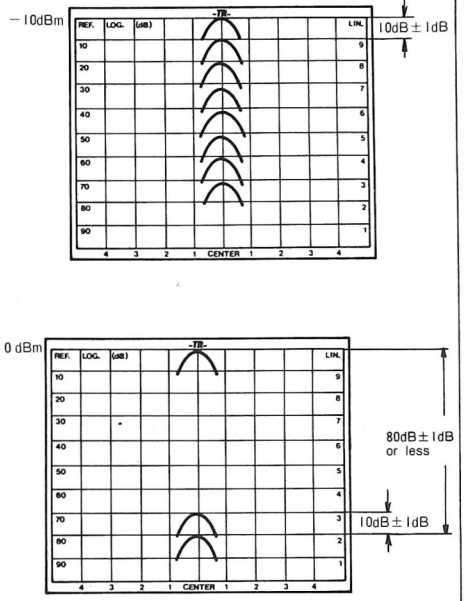


Fig. 3-10 CRT LOG. Scale Accuracy Test Display

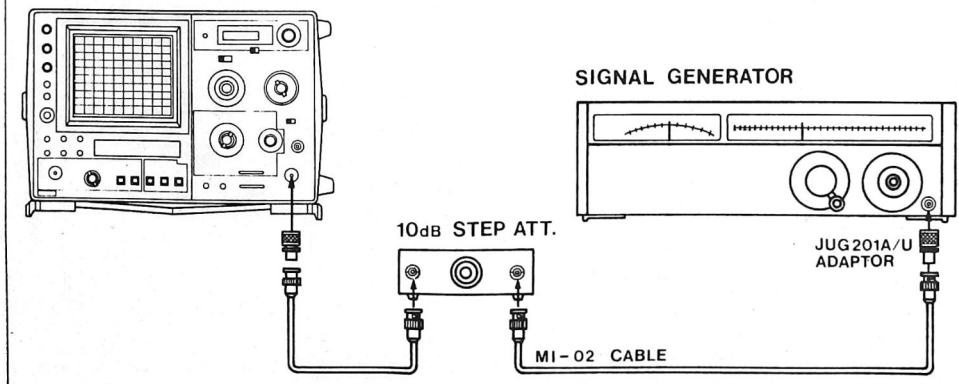


Fig. 3-8 CRT LOG. Scale Accuracy Test Setup (10 dB/DIV.)

3-4-4 CRT LOG. Scale Accuracy "2 dB/DIV."

Specification: Within ±0.4 dB/2 dB
Equipment used: Signal generator (S.G.)
Attenuator on 1 dB step

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   REFERENCE LEVEL ..... **–20 dBm**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **2 MHz/DIV.**
   TIME/DIV. ..... **5 ms/DIV.**
   VERT. MODE ..... **2 dB/DIV.**
2. Set the S.G. output to 200 MHz and –20 dBm and set the external attenuator to 0 dB. Connect each of them to the **INPUT** of the instrument as shown in [Fig. 3-11].
3. Turn the Reference level **ADJ.** control till the waveform peak comes on the top most line (**REF.**) of the CRT display.
4. Change the external attenuator sequentially from 0 dB to 10 dB. Make sure that the display variation is within 2 dB ±0.4 dB for the 1 dB step of the external attenuator. [Fig. 3-12]
5. Set the **REFERENCE LEVEL** to **–10 dBm** proceed as described in para. 4.

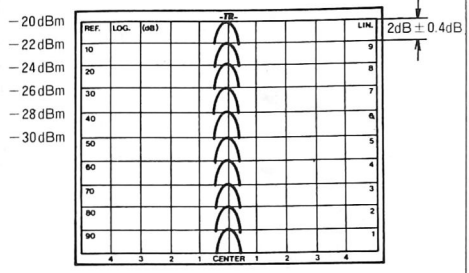


Fig. 3-12 CRT LOG. Scale Accuracy Test Display

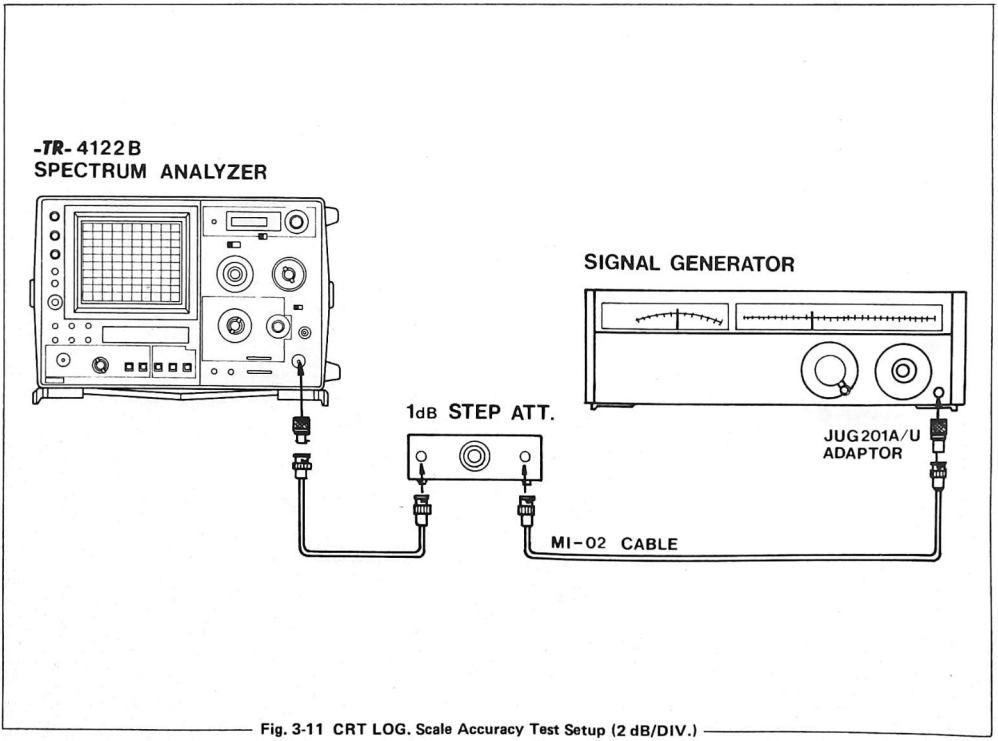


Fig. 3-11 CRT LOG. Scale Accuracy Test Setup (2 dB/DIV.)

3-4-5 CRT LINEAR Scale Accuracy

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   REFERENCE LEVEL ..... **0 dBm**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **2 MHz/DIV.**
   VERT. MODE ..... **LINEAR**
   INPUT ATT. ..... **10 dB**
2. Set the S.G. output to 200 MHz and −7 dBm (100 mVrms at 50 Ω), and feed it to the **INPUT** of the instrument.
3. Turn the **REFERENCE LEVEL—FINE** till the waveform peak comes to the top most line (**REF.**) of the CRT display.
4. Make sure that the waveform peak reading on the CRT display is within −7 dBm ±2 dB when VERT. MODE is set at 10 dB/DIV.

REF. LEVEL(dBm)	−10	−20	−30	−40	−50
Ext. ATT.(dB)	10	20	30	40	50

3-4-6 Reference Level Accuracy

Specification: Within 1 dB
(+20°C to +30°C)
Equipment used: Signal generator (S.G.)
Attenuator on 10 dB step

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **2 MHz/DIV.**
   VERT. MODE ..... **2 dB/DIV.**
2. Set the S.G. output to 200 MHz and −15 dBm, and set the external attenuator to 0 dB. Connect the S.G. output to the **INPUT** of -TR-4122B as shown in [Fig. 3-13].
3. Turn the **REFERENCE LEVEL—FINE** till the waveform peak comes on the scale in the center of the CRT display.
4. Make sure that the deviation from the center scale is less than 0.5 div. (1 dB) when the external attenuator and **REF. LEVEL** of the mainframe are set as shown in [Table 3-5].

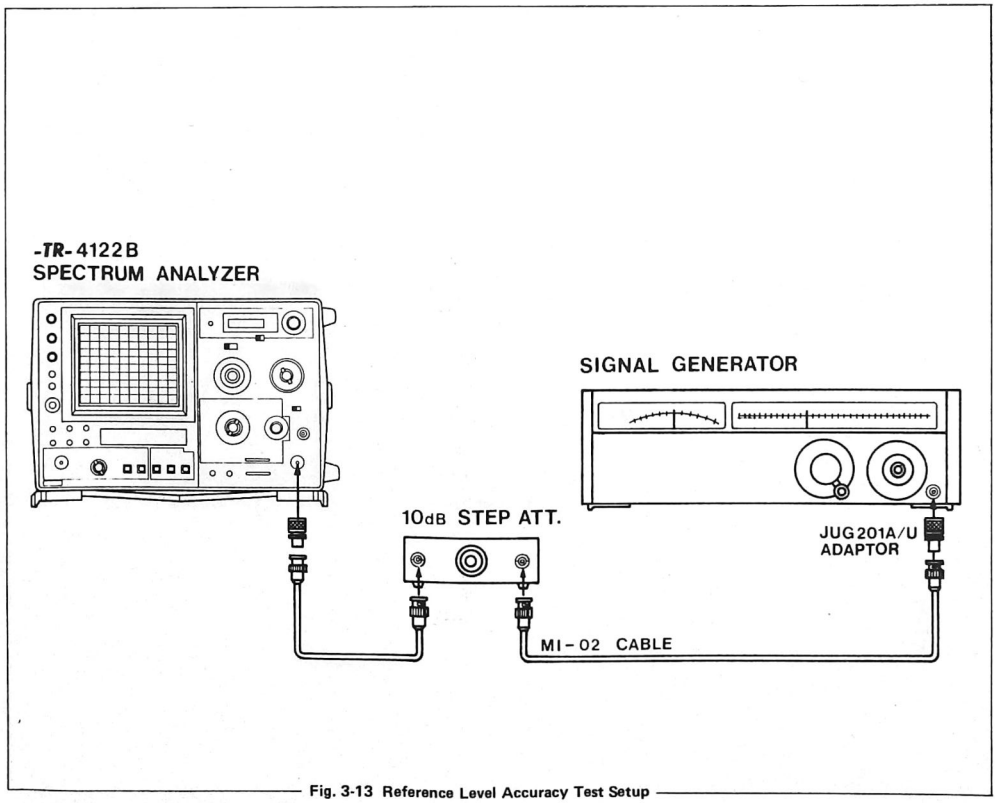


Fig. 3-13 Reference Level Accuracy Test Setup

3-4-7 RF Attenuator (INPUT ATT.) Accuracy

Specification: ±0.5 dB
Equipment used: Signal generator (S.G.)
Attenuator on 10 dB step

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   REFERENCE LEVEL ..... **–40 dBm**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
   TIME/DIV. ..... **5 ms/DIV.**
   VERT. MODE ..... **2 dB/DIV.**
   INPUT ATT. ..... **0 dB**
2. Set the S.G. output to 200 MHz and 0 dBm, and set the external attenuator to 50 dB. Connect each of them to the **INPUT** of the instrument as shown in [Fig. 3-14].
3. Turn the Reference level **ADJ.** control till the waveform peak comes to a scale in the center of the CRT display.
4. Make sure that the deviation from the center scale is within ±0.25 div. (±0.5 dB) when the external attenuator and **INPUT ATT.** are set as shown in [Table 3-6].

INPUT ATT.(dB)	10	20	30	40	50
Ext. ATT (dB)	40	30	20	10	0

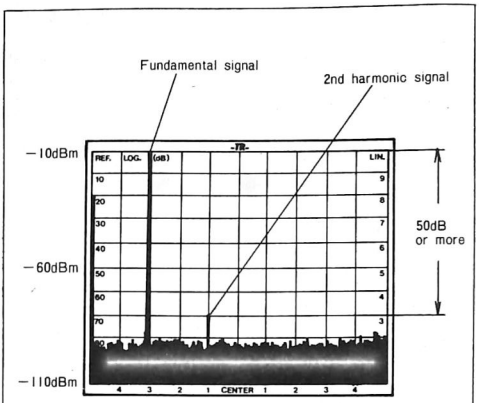


Fig. 3-17 Spurious Response Test Display

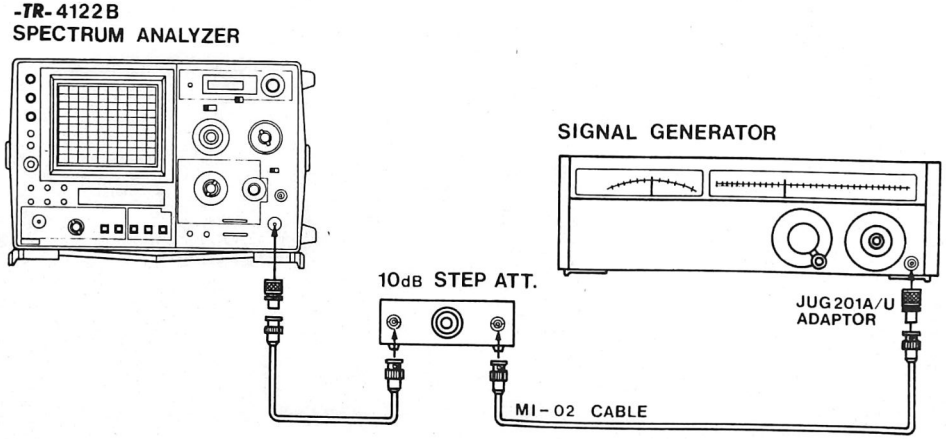


Fig. 3-14 RF Attenuator Accuracy Test Setup
Fig. 3-15 Gain Compression Test Procedure

3-4-8 Gain Compression

Specification: Less than −1 dB at −10 dBm input

Equipment used. Signal generator (S.G.)

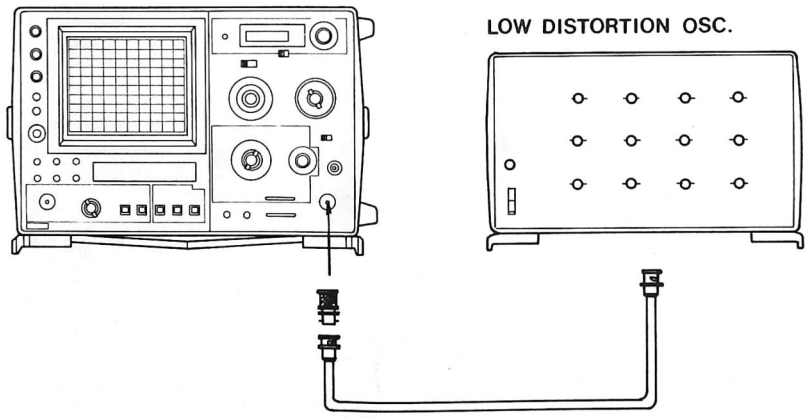
1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   REFERENCE LEVEL ..... **−10 dBm**
   BAND WIDTH ..... **1 MHz**
   DISPERSION/DIV. ..... **5 MHz/DIV.**
   TIME/DIV. ..... **5 ms/DIV.**
   VERT. MODE ..... **2dB/DIV.**
2. Set the S.G. output to 200 MHz and −20 dBm and connect it to the **INPUT** of the instrument as shown in [Fig. 3-15].
3. Turn the Reference level **ADJ.** control till the waveform peak comes to a scale in the center of the CRT display.
4. Make sure that the deviation from the center scale is below −1 dB when the **REFERENCE LEVEL** is reset to **0 dBm** and S.G. output is reset to −10 dBm.

3-4-9 Spurious Response

Specification: Below −70 dB (for input attenuator at 0 dB and −30 dBm input)

Equipment used: Low Distortion OSC.*1

1. Change the preliminary settings as follows:
   FREQUENCY ..... **500 MHz**
   REFERENCE LEVEL ..... **−10 dBm**
   BAND WIDTH ..... **1 MHz**
2. Set the low distortion oscillator output to −10 dBm and connect to the INPUT of the instrument. [Fig. 3-16]
3. Concerning each output frequency of the low distortion oscillator, make sure that the secondary harmonic signal level on the CRT display is not below the basic wave level by more than 50 dB. [Fig. 3-17]
   If the output frequency of the low distortion oscillator exceeds 500 MHz, set the **FREQUENCY** to **1000 MHz**.



*1 A combination of S.G. and L.P.F. may be used instead of the low distortion oscillator. In this case, the level of the secondary harmonic signal of the combined output must be lower by more than 70 dB than the basic wave −10 dBm.

Fig. 3-16 Spurious Response Test Setup

3-4-10 Frequency Response

Specification: For the range from 100 kHz to 1500 MHz
Within ±1 dB for input mixer
Within ±1 dB for input attenuator

Equipment used: Signal generator (S.G.)

1. Change the preliminary settings as shown below:
   FREQUENCY ..... **500 MHz**
   REFERENCE LEVEL ..... **–10 dBm**
   DISPERSION/DIV. ..... **100 MHz/DIV.**
   VERT. MODE ..... **2 dB/DIV.**
   INPUT ATT. ..... **10 dB**
2. Set the S.G. output to 200 MHz and –20 dBm and connect to the **INPUT** of the instrument.
3. Turn the Reference level **ADJ.** control till the waveform peak comes to a scale in the center of the CRT display.
4. Change the S.G. output frequency from 100 kHz to 1500 MHz and make sure that the level variation on the CRT display is within ±2 dB.

CAUTION

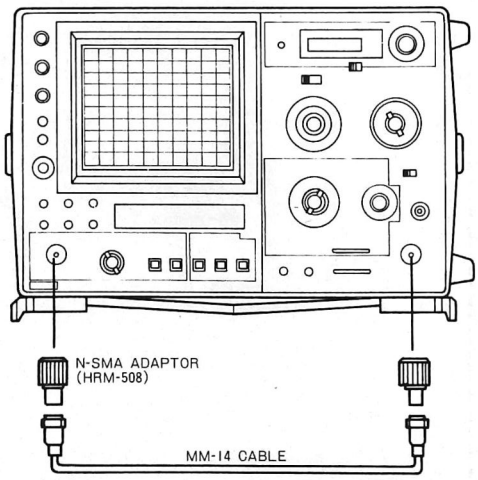
The frequency response of the S.G. itself is the error in measurement. Be sure to make correction.

5. By using the tracking generator output (400 kHz to 1500 MHz), the frequency characteristics can be observed at a glance. [Fig. 3-18]

3-4-11 Noise Sideband

Specification: Below –70 dB (20 kHz away from the carrier, with the band width 1 kHz and video filter ON)

1. Change the preliminary settings as follows:
   FREQUENCY ..... **0 MHz**
   BAND WIDTH ..... **1 kHz**
   DISPERSION/DIV. ..... **10 kHz/DIV.**
   TIME/DIV. ..... **1s/DIV.**
   VIDEO FILTER ..... **ON**
2. Turn the **TUNING** control till the zero frequency of the instrument comes to the center (**CENTER**) of the CRT display.
3. Operate the **REF. LEVEL** switch and the **REFERENCE LEVEL–FINE** control till the zero frequency peak comes to the top most line (**REF.**).
4. Make sure that the difference between the noise peak and waveform peak level at a point more than 20 kHz (2 div.) from the waveform center (**CENTER**) is more than 70 dB. [Fig. 3-19]



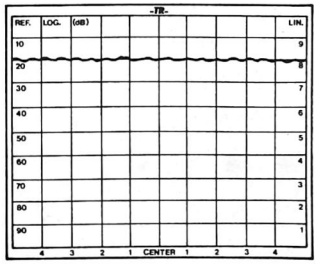


Fig. 3-18 Frequency Response Test with Incorporated T.G.

3-4-12 Residual FM

Specification: Less than 1 kHzp-p (at sweep time less than 50 ms/DIV.)

1. Change the preliminary settings as follows:
   FREQUENCY ..... **0 MHz**
   BAND WIDTH ..... **10 kHz**
   DISPERSION/DIV. ..... **2 kHz/DIV.**
   TIME/DIV. ..... **0.5s/DIV.**
2. Turn the **TUNING** control till the zero frequency of the instrument comes to the center (**CENTER**) of the CRT display.
3. Operate the **REF. LEVEL** switch and the **REFERENCE LEVEL—FINE** control till the zero frequency peak comes to the top most line (**REF.**).
4. Set the **DISPERSION/DIV.** to **0**, and turn the **TUNING—FINE** control till the waveform appears on the CRT display. Make sure that the level of the waveform during the variation in the vertical axis direction is less than 0.5 div. (1 kHz) for 1 div. on the horizontal axis.

3-5 Tracking Generator Section

The procedure to check the performance of the tracking generator built in this instrument is as follows.

3-5-1 Frequency Range and Frequency Response

Specification: ±1 dB for 400 kHz to 1500 MHz

Equipment used: Power meter

1. Change the preliminary settings as follows:
   DISPERSION/DIV. **0**
   T.G. MODE ..... **NORMAL**
   OUTPUT LEVEL ..... **0 dBm**
2. Connect the power meter to the **OUTPUT** connector. Turn the **TUNING** control slowly from 400 kHz to 1500 MHz. [Fig. 3-21] Make sure that the level indication deviation on the power meter is within ±1 dB.

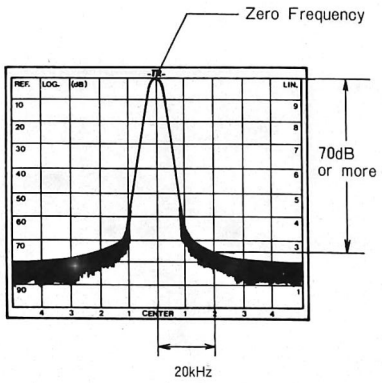


Fig. 3-19 Noise Sideband Check Display

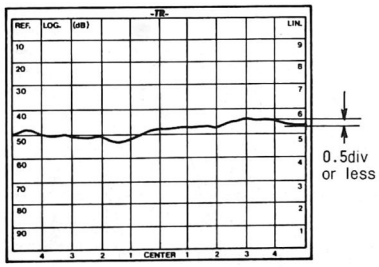


Fig. 3-20 Residual FM Check Display

3-5-2 Output Level Accuracy

Specification: Within ±1 dB
Equipment used: Power meter

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   DISPERSION/DIV. **0**
   T.G. MODE ..... **NORMAL**
   OUTPUT LEVEL ..... **0 dBm**
2. Connect the power meter to the **OUTPUT** connector. Make sure that the level indication on the power meter is within 0 dBm ±1 dB.

3-5-3 Output S/N Ratio

Specification: 30 dB
Equipment used: Spectrum analyzer

1. Change the preliminary settings as follows:
   DISPERSION/DIV. **0**
   T.G. MODE ..... **NORMAL**
2. Connect the **OUTPUT** connector with the input terminal of the spectrum analyzer on other than this instrument. [Fig. 3-22]
3. Make sure that the spurious level (except for harmonics) is more than 30 dB lower than the signal level when the **TUNING** control is turned from 400 kHz to 1500 MHz.

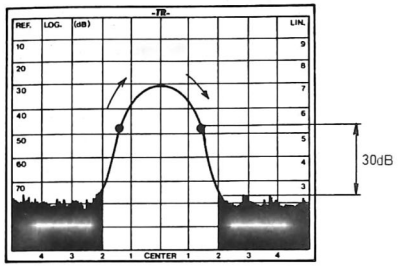


Fig. 3-23 Frequency Counter Range Check Display

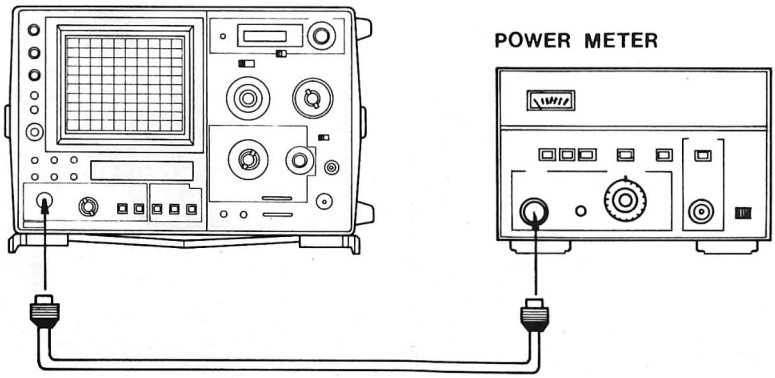


Fig. 3-21 T.G. Frequency Range and Frequency Response Check Display

3-6 Frequency Counter Section

The procedure to check the performance of the frequency counter incorporated into this instrument is as follows.

3-6-1 Frequency Range

Specification: 400 kHz to 1500 MHz

1. Change the preliminary settings as follows:
   TIME/DIV. ..... **10 ms/DIV.**
   BAND WIDTH ..... **3 MHz**
   DISPERSION/DIV. ..... **2 MHz/DIV.**
   T.G. MODE ..... **NORMAL**
   COUNTER RESOL. ..... **1 kHz**
2. Set the marker point, whose brightness is modulated, to the center of the CRT display.
3. Turn the **TUNING** control slowly from 400 kHz to 1500 MHz. Make sure that the **FREQUENCY COUNTER** LED display shows the correct counting according to the **FREQUENCY** dial display.
   Dial display accuracy is ±10 MHz and LED display varies for several counts for 1 kHz digit.
4. Set the **T.G. MODE** to the **TUNED AMP.** and connect the **CAL. OUT.** connector to the **INPUT** connector.
5. Set the **FREQUENCY** to **200 MHz** so that the waveform appears in the center of the CRT display.
   Turn the **MANUAL SWEEP** control till the marker point comes to a position left of waveform and about 30 dB above the noise level.
   Make sure that the **FREQUENCY COUNTER** shows the correct frequency (200 MHz ±30 kHz) of the CAL.signal.
6. As shown in [Fig. 3-23], set the marker point at a position in the center and at the right-hand section of the waveform and about 30 dB above the noise level, and make sure that the **FREQUENCY COUNTER** shows the same frequency for both cases.

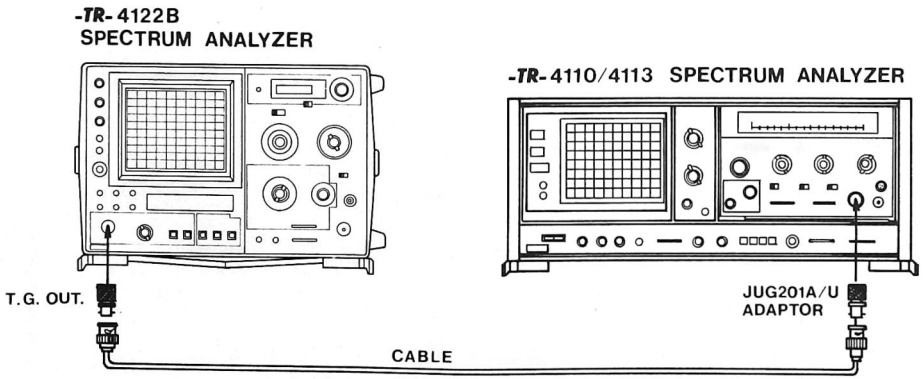


Fig. 3-22 T.G. Output Level Accuracy Test Setup

Table 3-7 PERFORMANCE CHECK LIST Serial No. _____

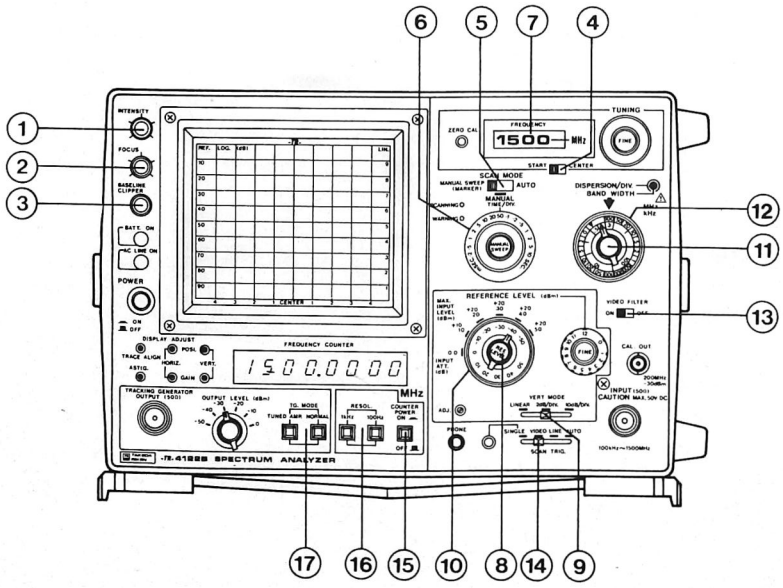
Preliminary Control Settings

1) Set **POWER MODE** on the rear panel to **AC** and set **POWER** on the front panel to **OFF.** Connect the power cable of the instrument to the **AC** power source.

2) Set the front panel controls as follows:

1. **INTENSITY** ..... CENTER
2. **FOCUS** ..... CENTER
3. **BASELINE CLIPPER** ..... Counterclockwise to limit
4. **START/CENTER** ..... **CENTER**
5. **SCAN MODE** ..... **MANUAL**
6. **TIME/DIV.** ..... **10ms/DIV.**
7. **FREQUENCY** ..... **0 MHz**
8. **REFERENCE LEVEL** ..... **0 dBm**
9. **VERT. MODE** ..... **10dB/DIV.**
10. **INPUT ATT.** ..... **0 dB**
11. **BAND WIDTH** ..... **3 MHz**
12. **DISPERSION/DIV.** ..... **200MHz/DIV.**
13. **VIDEO FILTER** ..... **OFF**
14. **SCAN TRIG.** ..... **AUTO**
15. **COUNTER POWER** ..... **ON**
16. **RESOL** **1kHz**
17. **TG. MODE** ..... **NORMAL**

3) Set **POWER** switch to **ON**, warm up the instrument for about one hour.



		Test Item	Specification				
Performance Check With CAL. OUT. Signal	1	Frequency Display Accuracy	Within ± 10 MHz				
	2	Scan Linearity	Within ± 10%				
	3	Band Width Accuracy	Within ± 20%				
	4	Band Width Switching Accuracy	Within ± 1 dB (+ 20°C to +30°C)				
	5	Average Noise Level (VIDEO FILTER; ON) BAND WIDTH; 1 MHz BAND WIDTH; 1 kHz	 Below –85 dBm Below –115 dBm				
	6	Residual Spurious Response (No Input signal, INPUT ATT. 0 dB)	Below –100 dBm				
Performance Test Using Measuring Instrument	7	CAL. OUT. Frequency Accuracy	200 MHz ± 30 kHz				
	8	CAL. OUT. Level Accuracy	–30 dBm ± 0.5 dB				
	9	CRT. LOG. Scale Accuracy VERT. MODE; 10 dB/DIV. VERT. MODE; 2 dB/DIV.	 Within ± 1 dB/10 dB Within ± 2 dB/80 dB Within ± 0.4 dB/2 dB				
	10	Reference Level Accuracy (+20°C to +30°C)	Within ± 1 dB				
	11	RF ATT. (INPUT ATT.) Accuracy	± 0.5 dB				
	12	Gain Compression (At –10 dBm input)	Less than – 1 dB				
	13	Spurious Response (INPUT ATT. 0 dB. Input – 30 dBm)	Below – 70 dB				
	14	Frequency Response	Within ± 2 dB				
	15	Noise Sideband (BAND WIDTH; 1 kHz, VIDEO FILTER; ON, 20 kHz away from the carrier)	Below –70 dB				
	16	Residual FM (TIME/DIV. less than 50ms)	Less than 1 kHzp-p				
T.G.	17	Frequency Range and Frequency Response	400 kHz to 1500 MHz ± 1 dB				
	18	Output Level Accuracy	Within ± 1 dB				
	19	Output S/N Ratio	30 dB or more				
Counter	20	Frequency Range	400 kHz to 1500 MHz				

CHAPTER 4
CALIBRATION AND ADJUSTMENT

4-1 General

This Chapter describes the calibration procedure which is made after the basic operation check and performance check of the **-TR-4122B** Spectrum Analyzer. When the instrument is repaired because of a faulty function, be sure to carry out the performance check and calibration before starting operation.

Numbers and symbols used for parts in this description are the same as imprinted or engraved on the circuit diagrams and boards.

4-2 Preparation and General Precautions

Necessary equipment and tools are listed in the table below. Equipment to be used must be those as listed in [Table 4-1] or equivalent.

4-2-1 Necessary Equipment and Tools

Equipment	Specifications		Recommended equipment
(1) Signal generator	Frequency: Output level: Output impedance: Output level flatness: Frequency accuracy:	100 kHz to 1500 MHz +10 dBm to −30 dBm 50 Ω ±0.5 dB ±0.01%	
(2) Frequency counter	Frequency: Sensitivity: Stability:	10 Hz to 1500 MHz 10 mVrms 5×10^{-8}/day	Takeda Riken **-TR-5123G**
(3) High frequency power meter	Frequency: Sensitivity: Accuracy:	100 kHz to 1500 MHz −30 dBm to +20 dBm ±0.5 dB	HP-436A
(4) Attenuator	Frequency: Attenuation: Accuracy:	DC to 500 MHz 10 dB step 0 to 100 dB 1 dB step 0 to 10 dB ±0.5 dB	
(5) Low distortion oscillator	Frequency: Harmonic distorsion: Output level:	5 MHz to 750 MHz Less than −80 dB −10 dBm (50 Ω)	
(6) Spectrum analyzer	Frequency: Input sensitivity: Resolution (IF B.W.):	400 kHz to 2000 MHz −120 dBm 30 Hz to 300 kHz	Takeda Riken **-TR-4110/4111**
(7) Digital multimeter	Measuring range: Accuracy: Input impedance:	0 V to ± 1000 V ± 0.1% 10 MΩ or more	Takeda Riken **-TR-6855**
(8) DC high-voltage prove	Measuring range:	+5 kV to −2 kV	Takeda Riken **-TR-1116**

Table 4 – 1 Equipment Necessary for Calibration

Commodity	Stock No.	Remarks
Input cable	**MI-02**	BNC-BNC
Connection cable	**MC-36**	BNC-UM
Connection cable	**MC-37**	BNC-SMA
Connection cable	**MC-61**	BNC-BNC
Connection cable	**MM-14**	SMA-SMA
Connection cable	**MM-17**	UM-UM
Conversion adaptor	**JUG201**	JUG-201A/U
UM-UM linear adaptor		UM-QA-JJ
SMA-SMA Adaptor		HRM-501
Adiustment board	**CY-822**	22pin, double

Table 4 – 2 Tools and Jigs Necessary for Calibration

4-2-2 Preparation for Calibration

1. Always operate the instrument on AC 100 V (120 V, 200 V, 220 V, or 240 V) ±10% with a line frequency of 50 Hz or 60 Hz.
2. Always confirm that the **POWER** switch is **OFF** before connecting the power cable to the AC line.
3. Carry out the calibration in an environment with a temperature +20°C to +30°C with humidity below 80% and in a place free from dust, vibration, and noise.

4-2-3 Preliminary Control Setting

1. Set the **POWER MODE** switch on the rear panel to **AC** and the **POWER** switch on front panel to **OFF**.
2. Connect the power cable to an AC line with a voltage corresponding to that imprinted on the rear panel.
3. Set the front panel controls as follows:

INTENSITY ..... Center
FOCUS ..... Center
BASELINE CLIPPER ... Counterclockwise to limit
START/CENTER ..... **CENTER**
SCAN MODE ..... **MANUAL**
TIME/DIV. ..... **5 ms/DIV.**
DISPERSION/DIV. ..... **100 MHz/DIV.**
BAND WIDTH ..... **1 MHz**
VIDEO FILTER ..... **OFF**
REFERENCE LEVEL ..... **0 dBm**
INPUT ATT. ..... **0 dB**
VERT. MODE ..... **10 dB/DIV.**
SCAN TRIG. ..... **AUTO**
FREQUENCY ..... **200 MHz**
COUNTER POWER ..... **OFF**

4-3 Power Source Adjustment

1. With the **POWER** switch **OFF**, measure the impedance at the test point [Fig. 4-1] of board SE160. Measured values are obtained using a resistance range of applied current 100 μA for the measurement on a digital multimeter.
2. Set the **POWER** switch to **ON**, and measure the voltage at each test point. [Fig. 4-1] shows the adjustment control position. Operate the control corresponding to each test point to adjust the voltage to that shown in [Table 4-3].

Test point	Impedance	Voltage	Adjusting Control
TP-1	∞	+150V	R39
TP-2	∞	+28.0V	R32
TP-3	Approx. 102Ω	+5V	No adjustment
TP-4	Approx. 184Ω	−15.00V	R25
TP-5	Approx. 64Ω	+15.00V	R22
TP-6	0	GND	

Table 4 – 3 Power Source Adjustment

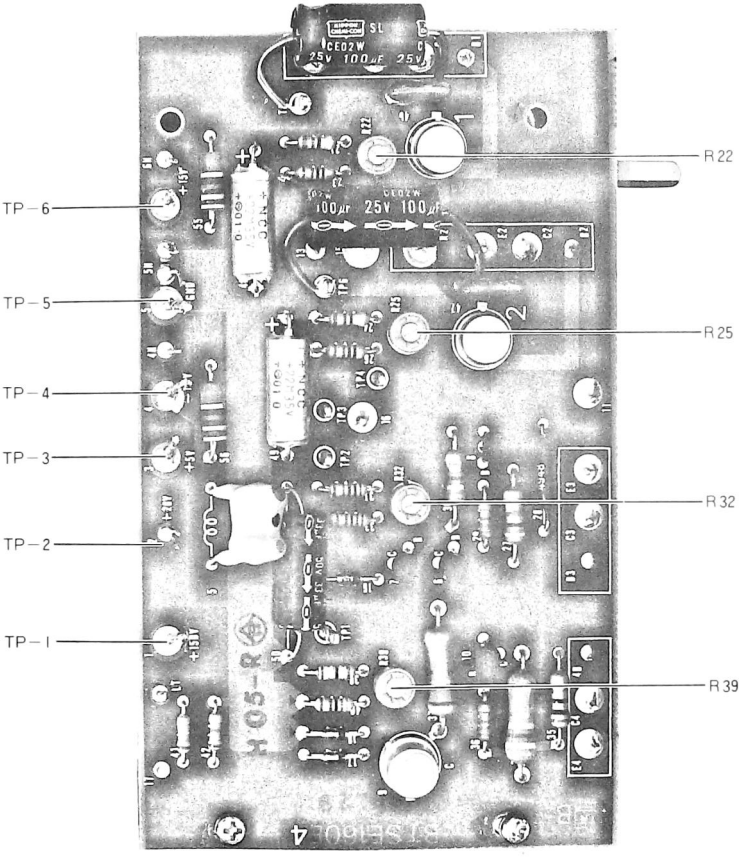


Fig. 4-1 Location of Power Source Adjustment V.R.

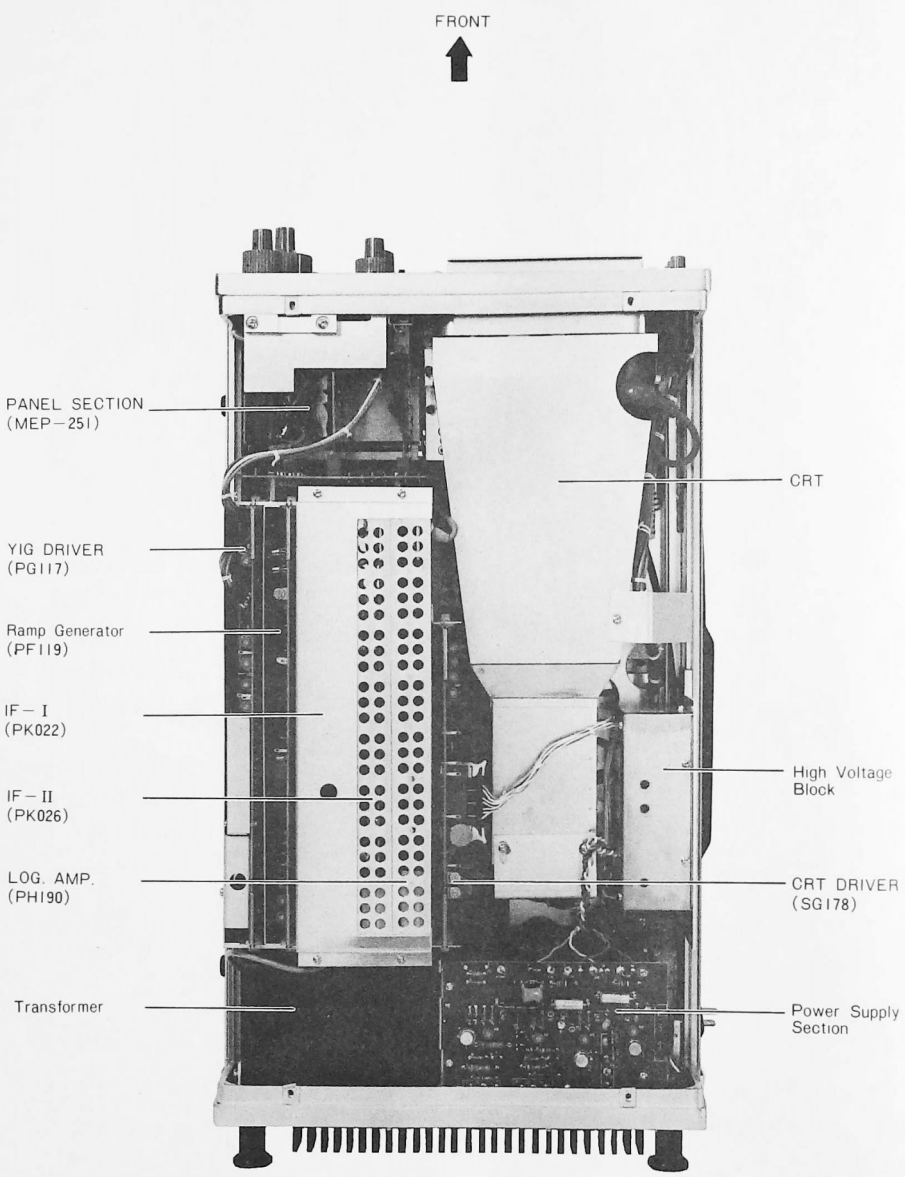


Fig. 4-2 Top View

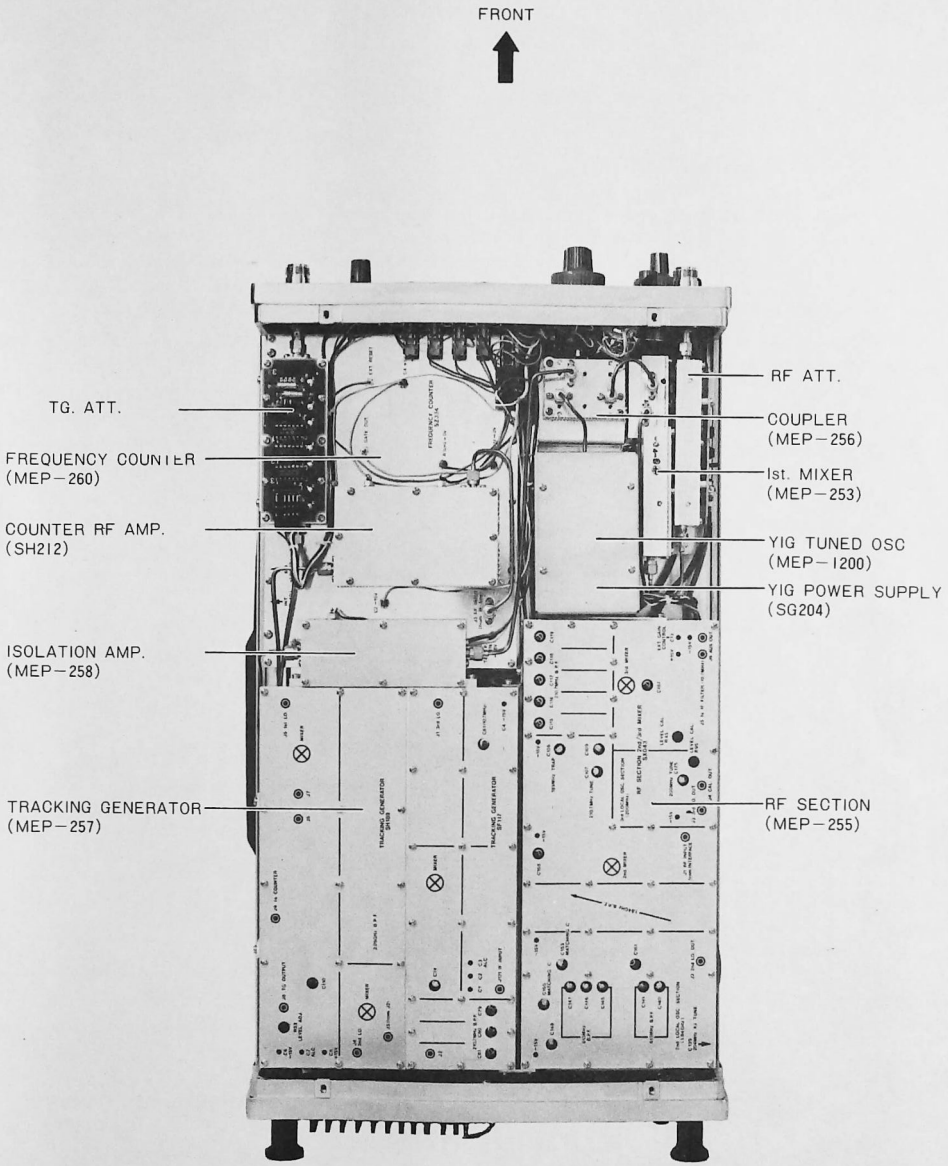


Fig. 4-3 Bottom View

4-4 Checking the High-voltage Power Source

1. Set the **POWER** switch to **OFF**.
2. Pull out the board SG178 (CRT driver) and disconnect the connector J236. Remove two CRT set screws and disassemble the CRT socket and anode key from the CRT.

CAUTION

After the removal of the anode cap, keep away from the connector on the CRT side.

3. Set the **POWER** switch to **ON**.
   Check the voltage at each terminal of the CRT socket and at the anode cap. Because of high voltage, take utmost care when measuring and use the high-voltage probe together with a digital multimeter.

Socket No.	Voltage
10, 11pin	(H) −1.5kV
12pin ※1	(G_1) approx. −1.52kV to −1.60kV
13pin ※2	(K) −1.5kV
14pin ※3	(P_1) approx. −1.11kV to 1.42kV
Anode cap	+5kV

*1 is adjusted by the **INTENSITY** control, *2 by the VR-1 in high-tension case, and *3 by the **FOCUS** control.
When adjusting VR-1, use a high voltage resistant screwdriver.

4. After the checking of each voltage, set the **POWER** switch to **OFF**, mount the CRT socket and anode cap to the CRT, and fix the CRT with screws.
   Insert the board SG178 and connect the connector.

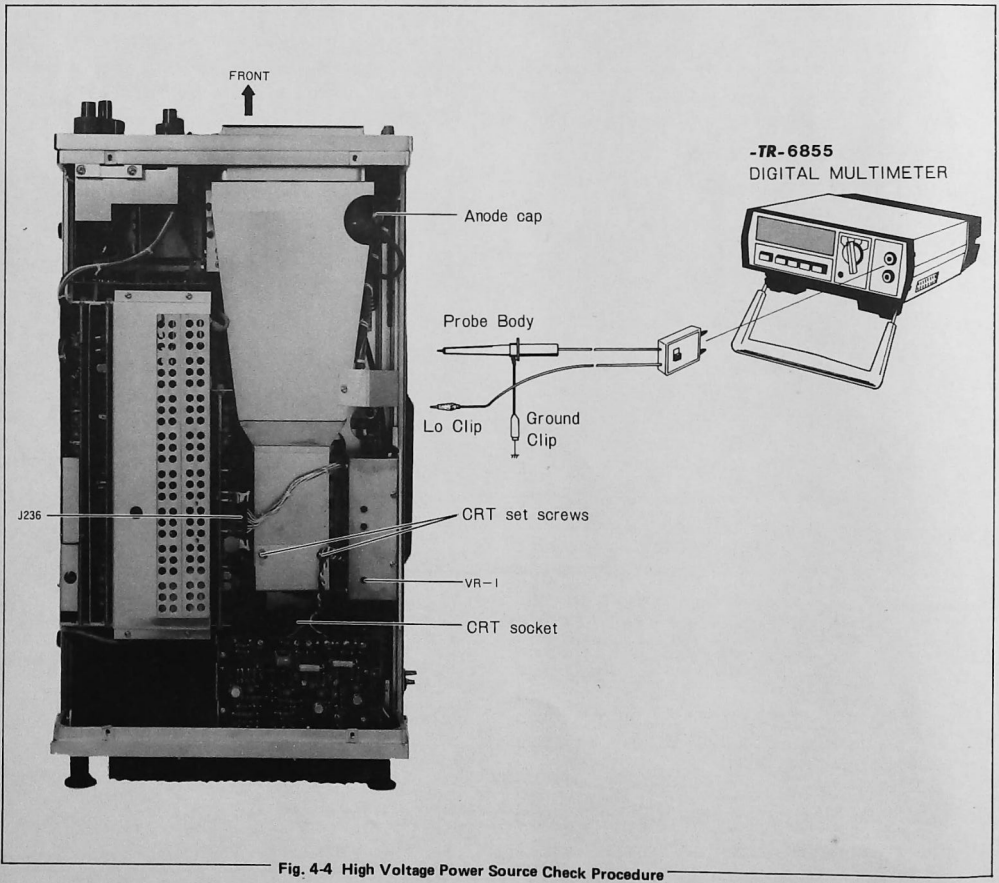


Fig. 4-4 High Voltage Power Source Check Procedure

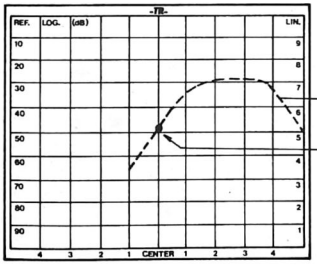
4-5 CRT Driver Adjustment (Board code: SG178)

Equipment used: Digital Voltmeter

1. Set the **POWER** switch to **OFF** and pull out the board SG178.
2. Mount the board SG178 via attached adjustment board **CY-822**.

4-5-1 Adjustment of INTENSITY, FOCUS, and CRT Distortion

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   SCAN MODE ..... **MANUAL SWEEP**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
   BAND WIDTH ..... **3 MHz**
2. Connect the **CAL. OUT.** connector and the **INPUT** connector.
3. Turn the **MANUAL SWEEP** control till the marker point comes to the center of the horizontal axis of the CRT display.
4. Turn the **TUNING** control till the marker point comes to the edge of the 200 MHz CAL. signal waveform and set it to the center of the horizontal axis. [Fig. 4-3]
5. Turn the **FOCUS** control to the limit clockwise to darken the bright point.
6. Turn R176 (G2) till the marker point becomes brightest.
7. Turn the **FOCUS** control till the marker point is distinctly focused.
8. Turn the **ASTIG.** control on the front panel till the marker point is distinctly focused. [Fig. 4-8]
9. Change the preliminary settings as follows:
   SCAN MODE ..... **AUTO**
   DISPERSION/DIV. ..... **10 MHz/DIV.**
   BAND WIDTH ..... **100 kHz**
   REFERENCE LEVEL ..... **–30 dBm**
   VERT. MODE ..... **2 dB/DIV.**
10. Feed the CAL. signal to the **INPUT** connector, and turn the **TUNING** control till the waveform comes to the left most line on the CRT display. Measure the distortion of the waveform relative to the left most line. Take the same steps for the center and right most line on the CRT display. Adjust R178 till the distorsion becomes less than 0.1 div. for all three points.



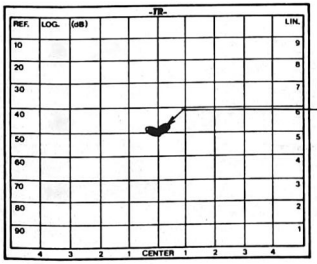


Fig. 4-7 FOCUS Adjustment — Fig. 4-8 FOCUS Adjustment

4-5-2 Vertical Axis Adjustment

1. Change the preliminary settings as follows:
   SCAN MODE ..... **AUTO**
   DISPERSION/DIV. **0**
   BAND WIDTH ..... **1 MHz**
   REFERENCE LEVEL ..... **–30 dBm**
   REFERENCE LEVEL–FINE .... **–5 dBm**
2. Feed the CAL. signal to the **INPUT** connector, and turn the **TUNING** control till the waveform comes to the top most line (**REF.**) on the CRT display.
3. Connect the digital voltmeter to TP-1, and turn the **TUNING** control till +5.00 V is obtained. Adjust R83 so that the trace keeps its position on the CRT display even when **VERT. MODE** is changed to **2 dB/DIV.**
4. Set the **REFERENCE LEVEL** to **–20 dBm**. Turn the **TUNING** control till TP-1 indicates +2.50 V voltage.
5. Turn the **VERT. POSI.** control till the trace comes to the center of the vertical axis of the CRT display.
6. Set the **REFERENCE LEVEL** to **–30 dBm** again. Turn the **TUNING** control till TP-1 indicates +5.00 V voltage.
7. Turn the **VERT. GAIN** control till the trace comes to the top most line of the CRT display.
8. Repeat steps 3 to 7.
9. Set **VERT. MODE** to **2 dB/DIV.** Turn the **TUNING** control till TP-1 indicates +4.10 V voltage. In this case, adjust R89 so that the trace comes to the second line from the bottom on the vertical axis.
10. In this condition, set the **REFERENCE LEVEL** to **0 dBm**. Adjust R111 so that the trace comes to the bottom line on the horizontal axis.
11. Set **VERT. MODE** to **10 dB/DIV.**, **REFERENCE LEVEL** to **0 dBm**, and **BAND WIDTH** to **0.5 kHz**.
    Connect the digital voltmeter to TP-6, and adjust R253 so that 0 V voltage is obtained.

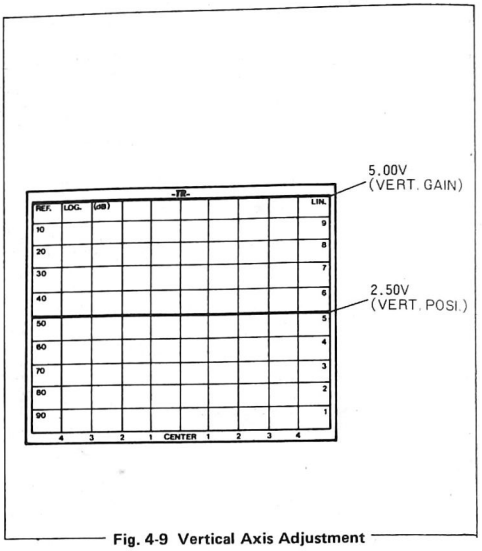


Fig. 4-9 Vertical Axis Adjustment

4-5-3 Horizontal Axis Adjustment

1. Change the preliminary settings as follows:
   SCAN MODE ..... **AUTO**
   DISPERSION/DIV. **0**
   BAND WIDTH ..... **3 MHz**
   REFERENCE LEVEL ..... **0 dBm**
   VERT. MODE ..... **10 dB/DIV.**
2. Feed the CAL. signal to the **INPUT** connector. Turn the **TUNING** control till the waveform comes to the center line of the horizontal axis.
3. Set **SCAN MODE** to **MANUAL SWEEP**. Connect the digital voltmeter to TP-8. Turn the **MANUAL SWEEP** control till the voltmeter indicates 0.00 V.
4. Turn the **HORIZ. POSI.** control on the front panel till the marker point comes to the center of the CRT display.
5. Turn the **MANUAL SWEEP** control to shift the trace leftward.
   This is to obtain –5.00 V on TP-8.
6. Turn the **HORIZ. POSI.** control on front panel till the trace comes to the left most line on the CRT display.
7. Set the **POWER** switch to **OFF** and return the board SG178 to original condition.

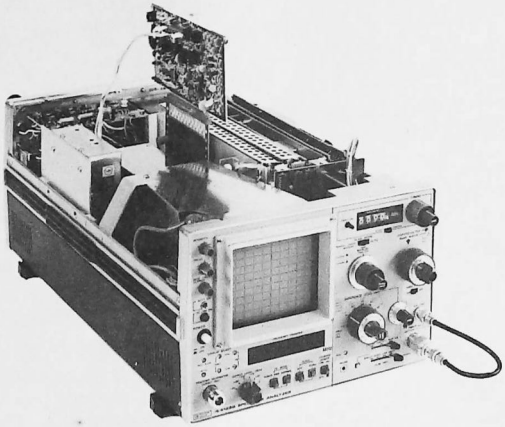


Fig. 4-5 Adjustment Board (CY-822) Reference Diagram

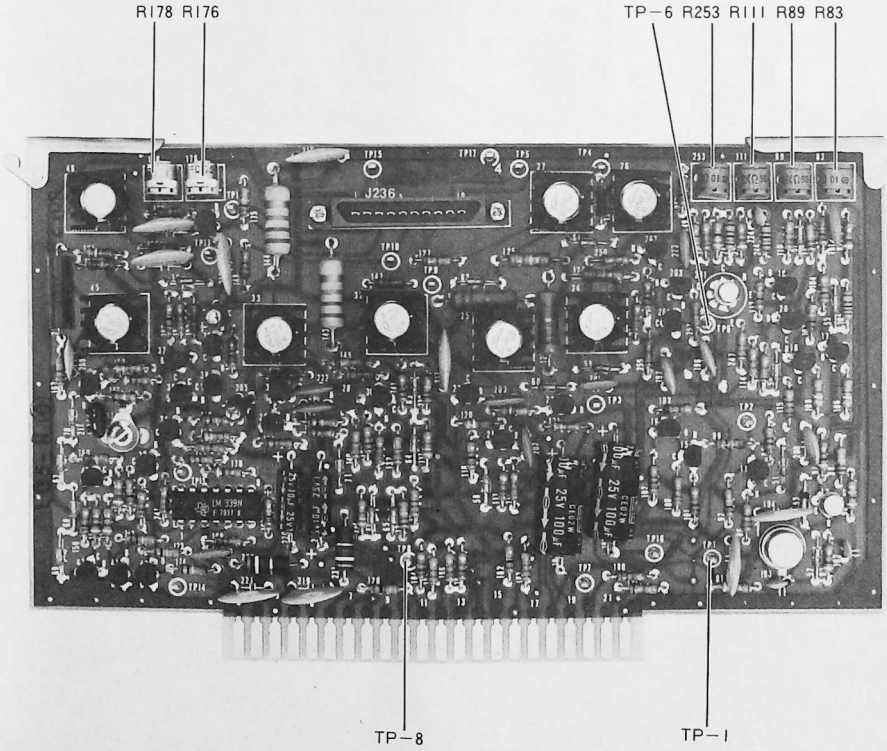


Fig. 4-6 Location of CRT DRIVER (SG178) Adjustment

4-6 YIG Driver Adjustment (Board code: PG177)

Equipment used: Digital Voltmeter
Signal Generator (S.G.)

1. Set the **POWER** switch to **OFF** and pull out the board PG177.
2. Mount the board PG177 via the attached adjustment board **CY-822**. [Fig. 4-10]

4-6-1 10 V, −5 V Adjustment

1. Connect the digital voltmeter to TP-2, and adjust R110 till the voltmeter indicates +10.00 V.
2. Connect the digital voltmeter to 11B pin of connector J1, and adjust R121 till the voltmeter indicates −5.00 V.

4-6-2 Scan Linearity Adjustment

1. Change the preliminary settings as follows:
   FREQUENCY ..... **100 MHz**
   TIME/DIV. ..... **5 ms/DIV.**
   DISPERSION/DIV. ..... **20 kHz/DIV.**
   BAND WIDTH ..... **1 MHz**
2. Feed the CAL. signal to the **INPUT** connector Turn the **TUNING** control till the zero frequency spectrum comes to the left most line of the CRT display.
3. Adjust R175 so that the 200 MHz CAL. signal comes to the right most line of the CRT display. In this case, the zero frequency shifts also, and thus should be readjusted by the **TUNING** control.
4. Change the settings as follows:
   FREQUENCY ..... **5 MHz**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
   BAND WIDTH ..... **100 kHz**
5. Cancel the CAL. signal and feed 10.00 MHz, −20 dBm signal from S.G. Turn the **TUNING** control till the zero frequency comes to the left most line of the CRT display. Adjust R196 so that the 10 MHz signal comes to the right most line of the CRT display. In this case, the zero frequency shifts also, and thus should be readjusted by the **TUNING** control.

4-6-3 Adjustment of Dial Scale Accuracy

1. Turn the **FREQUENCY−ZERO CAL.** control 2.5 turns clockwise from the counterclockwise limit and the **TUNING−FINE** control 5 turns clockwise from the counterclockwise limit.
2. Change the preliminary settings as follows:
   TIME/DIV. ..... **5 ms/DIV.**
   DISPERSION/DIV. ..... **5 MHz/DIV.**
   BAND WIDTH ..... **1 MHz**
3. Set S.G. output to 500.0 MHz, 0 dBm and connect it to the **INPUT** connector of the instrument.
4. Set the **FREQUENCY** mechanical counter to **0000 MHz**. Adjust R86 so that the zero frequency waveform comes near to the point distanced 0.3 div. to the right of center of the CRT display.
5. Set the **FREQUENCY** mechanical counter to **1500 MHz**. Adjust R83 so that the triple harmony of the S.G. output frequency 500 MHz comes to a point distanced 0.2 div. to the right from the center of the CRT display.
6. Set the mechanical counter again to 0000 MHz. Set the **DISPERSION/DIV.** to **100 MHz/DIV.** once and return it to **5 MHz/DIV.** again.
7. Repeat the procedure from 4 to 6 till the dial scale accuracy is within ±10 MHz.

4-6-4 START/CENTER Switch Adjustment

1. Change the preliminary settings as follows:
   TIME/DIV. ..... **5 ms/DIV.**
   DISPERSION/DIV. ..... **5 MHz/DIV.**
   BAND WIDTH ..... **1 MHz**
2. Turn the **TUNING** control till the zero frequency comes to the center (**CENTER**) of the CRT display. Adjust R128 so that the zero frequency comes to the left most line of the CRT display when the **START/CENTER** switch is set to **START**.
3. Set the **POWER** switch to **OFF** and return the board PG177 to its original condition.

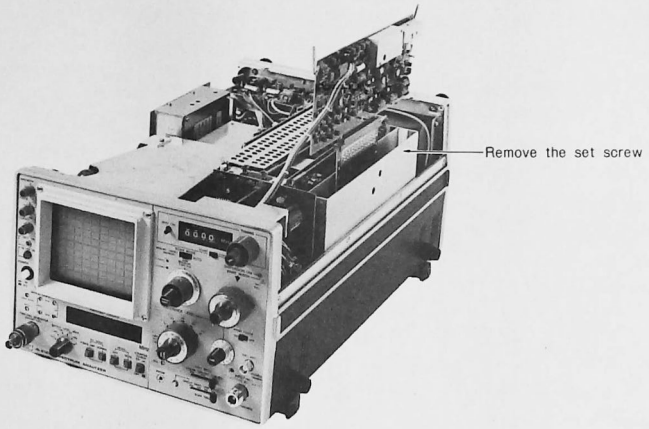


Fig. 4-10 Replacement Board PG177 (YIG DRIVER)

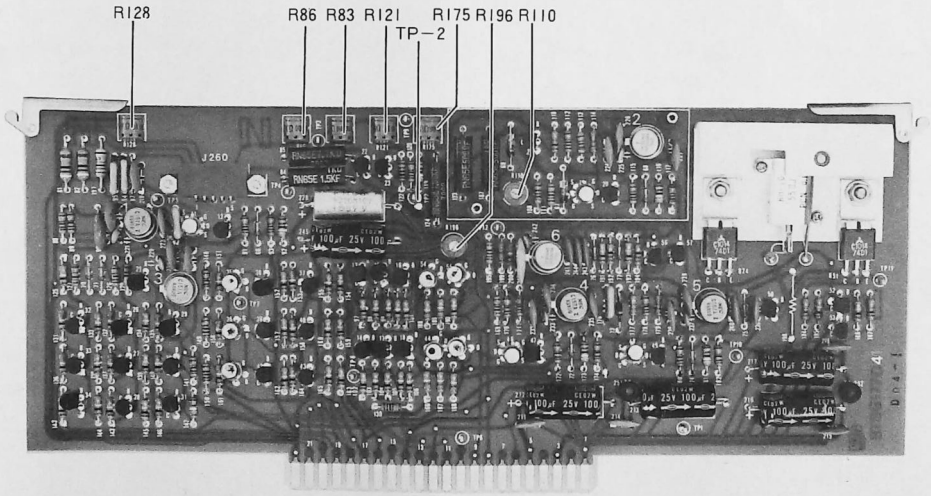


Fig. 4-11 Location of YIG DRIVER (PG177) Adjustment

4-7 Ramp Generator Adjustment (Board code: PF119)

Equipment used: Digital Voltmeter
Signal Generator (S.G.)
1 kHz
Internal AM modulation must be possible.

1. Set the **POWER** switch to **OFF** and pull out the board PF119.
2. Mount the board PF119 via the attached adjustment board **CY-822**.

4-7-1 10 V Adjustment

1. Connect the digital voltmeter to TP-2. Adjust R72 till the voltmeter indicates + 10.00 V.

4-7-2 Scan Time Adjustment

1. Change the preliminary settings as follows:
   FREQUENCY ..... **200 MHz**
   TIME/DIV. ..... **1 ms/DIV.**
   DISPERSION/DIV. **0**
   BAND WIDTH ..... **3 MHz**
   REFERENCE LEVEL ..... **0 dBm**
   SCAN TRIG. ..... **VIDEO**
2. Feed the 1 kHz AM-modulated signal of 200 MHz. −20 dBm from S.G. to the **INPUT** connector.
3. Turn the **TUNING** control till the modulated waveform appears on the CRT display. [Fig. 4-12]
4. Change the modulation until the p-p value of the modulated waveform becomes 1 div.
5. Turn R144 to apply video trigger.
6. Change the modulation till the p-p value of the modulated waveform becomes 2 div. Adjust R78 so that 1 div. becomes equal to 1 cycle for the setting of **TIME/DIV.** to **1 ms/DIV.**
7. Adjust R81 so that 1 div. becomes equal to 2 cycles for the setting of **TIME/DIV.** to **2 ms/DIV.**
8. Repeat 6 and 7 procedures above till the scan time is within ±10%.
9. Set the **POWER** switch to **OFF**, and reset the board PF119.

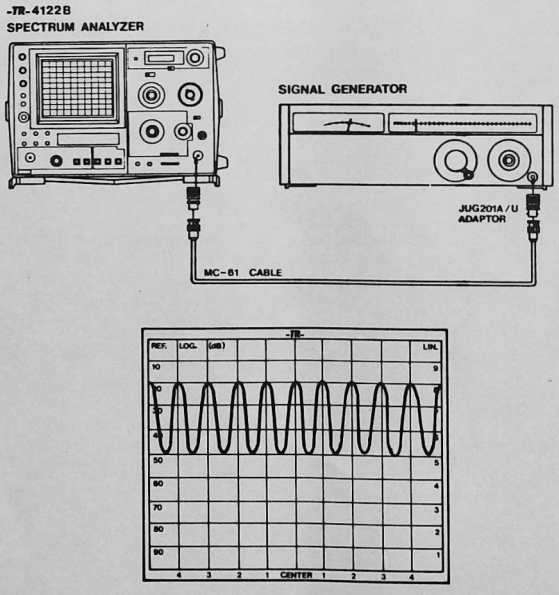
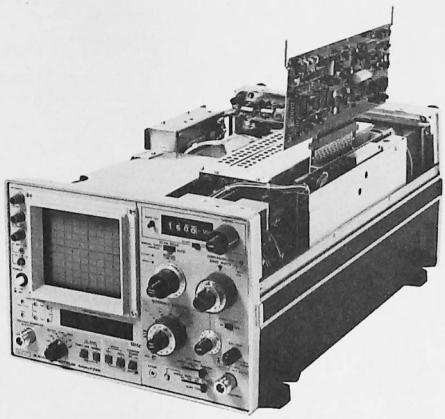


Fig. 4-12 SCAN TIME Adjustment



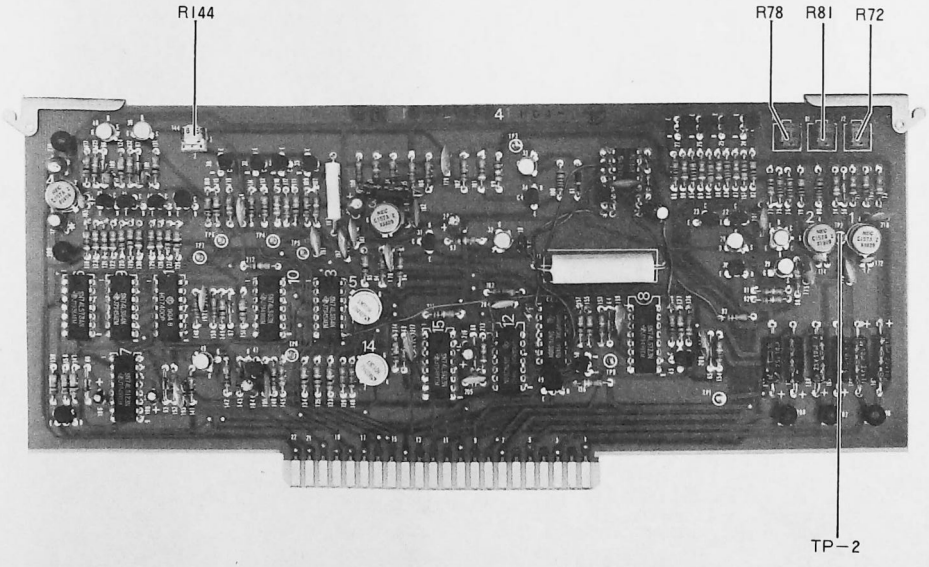


Fig. 4-13 Location of RAMP GENERATOR (PF119) Adjustment

4-8 LOG. AMP. Adjustment (Board code: PH190)

Equipment used: Signal generator (S.G.), Digital Voltmeter, Attenuator 10 dB step

1. Set the **POWER** switch to **OFF** and pull out the board PH190.
2. Reset board PH190 via the attached adjustment board **CY-822**.

4-8-1 Adjustment of LINEAR REFERENCE LEVEL 40 dB, 50 dB

1. Feed the 10.700 MHz, +4.0 dBm signal from S.G. to J488 LOG. AMP. input of the board PH190 via the external attenuator as shown in [Fig. 4-14]. Set the external attenuator to 10 dB and set **VERT. MODE** to **LINEAR**.
2. Connect the digital voltmeter to TP-15 and read the voltage when the **REFERENCE LEVEL** is set at **–30 dBm**. This voltage is called V_1.
3. Read the voltage on TP-15 when the **REFERENCE LEVEL** is set at **–40 dBm**. This voltage is called V_2.
4. Adjust R298 so that V_1 is equal to V_2.
5. Repeat procedures from 2 to 4.

4-8-2 LOG. Linearity Adjustment

1. Set **VERT. MODE** to **10 dB/DIV.**
2. Adjust R240 so that TP-15 voltage is +1.500 V ±10 mV when the external attenuator is set to 70 dB.
3. Adjust R261 so that TP-15 voltage becomes +5.00 V ±10 mV when the external attenuator is set to 0 dB.
4. Repeat procedures 2 and 3 above.
5. Set the external attenuator to 0 dB and the **BAND WIDTH** to **100 kHz**, and S.G. output frequency to 10.700 MHz.
6. Turn C400 till TP-15 voltage is highest.
7. Adjust R264 so that TP-15 keeps constant voltage when the **BAND WIDTH** is changed to **1 MHz** and **100 kHz.**

4-8-3 LINEAR Linearity Adjustment

1. Set **VERT. MODE** to **LINEAR**. Disconnect the connection cable from S.G. Adjust R243 so that TP-15 voltage becomes 0.000 V ±10 mV.
2. Reconnect the connection cable to S.G., and adjust the output to 10.700 MHz, –3 dBm. Set the external attenuator to 0 dB and adjust R191 till the voltage of TP-15 is +5.00 V.

4-8-4 Adjustment of LOG. REFERENCE LEVEL 40 dB, 50 dB

1. Set **VERT. MODE** to **10 dB/DIV.**
2. Set the output of S.G. to 10.700 MHz, +4 dBm.
3. Set the external attenuator to 10 dB, and read the voltage of TP-15 when the **REFERENCE LEVEL** is set at **–30 dBm**. This voltage is referred to as V_3.
4. Set the external attenuator to 20 dB, and adjust R246 till the voltage of TP-15 becomes equal to V_3 when the **REFERENCE LEVEL** is set at **–40 dBm**.
5. Set the external attenuator to 30 dBm, and adjust R248 until the voltage of TP-15 becomes equal to V_3 when the **REFERENCE LEVEL** is set at **–50 dBm**.
6. Set the **POWER** switch to **OFF** and reset the board PH190.

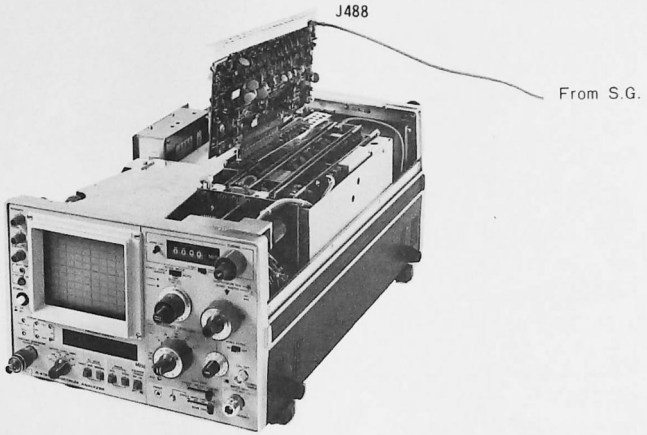


Fig. 4-14 LOG. AMP. Adjustment Setup

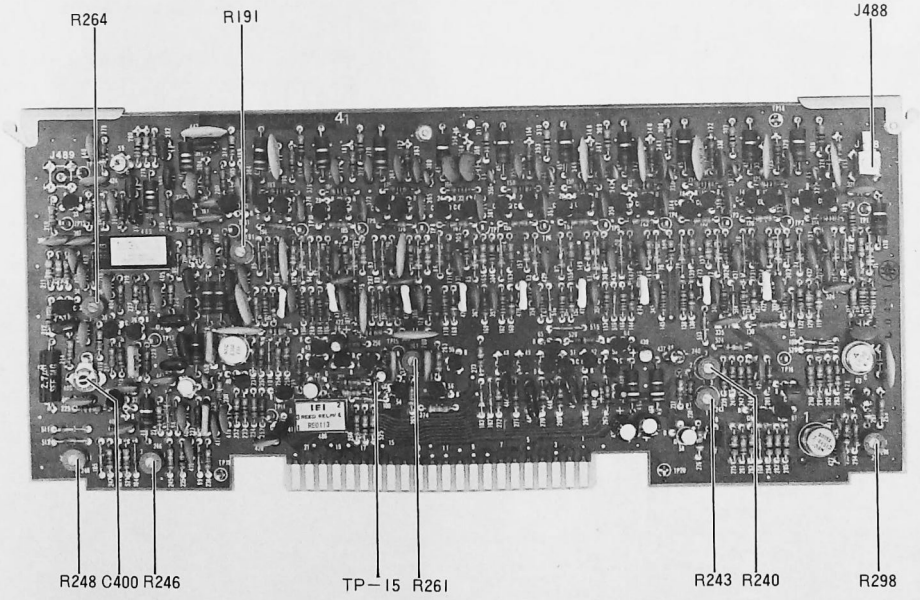


Fig. 4-15 Location of LOG. AMP. (PH190) Adjustment

4-9 IF-II Adjustment (Board code: PK026)

Equipment used: Signal Generator (S.G.)
Attenuator on 10 dB step

1. Set the **POWER** switch to **OFF** and pull out the board PK026.
2. Mount the board PK026 via the attached adjustment board **CY-822**.

4-9-1 Adjustment of the 10 kHz Band Width Symmetry

1. Prepare two UM-UM cables (**MM-17**). Each cable is to be used to connect the IF-II input (J296) with the LOG AMP input (J488). Turn the **TUNING** control till the zero frequency comes to the center (**CENTER**) of the CRT display.
2. Change the preliminary settings as follows:
   TIME/DIV. ..... **10 ms/DIV.**
   DISPERSION/DIV. ..... **10 kHz/DIV.**
   BAND WIDTH ..... **10 kHz**
3. Turn C252 till the zero frequency comes to the minimum level.
4. Turn C251 till the optimum symmetry is obtained for the 10 kHz band width. [Fig. 4-16]
5. Since C252 and C251 are related to each other, repeat 3. and 4. above.
6. Set the **BAND WIDTH** to **100 kHz** and the **DISPERSION/DIV.** to **50 kHz/div.**, then adjust C244 till the center of the waveform in this setting coincides with that of the **10 kHz BAND WIDTH**.

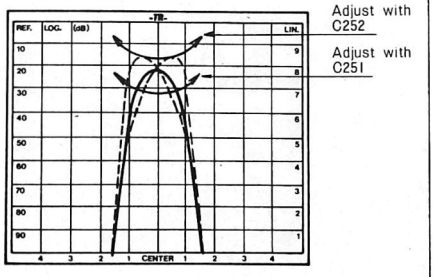


Fig. 4-16 Adjustment of the 10 kHz Band Width Symmetry

7. Disconnect the cable between the IF-II input (J296) and the IF-I output (J402), and feed the 10.700 MHz, −10 dBm signal from S.G. to IF-II input (J296).
8. Changeover the **BAND WIDTH** to **3 MHz** and **100 kHz** and adjust R165 till the level difference between these band widths becomes zero.
9. Set the **BAND WIDTH** to **0.5 kHz**, and adjust R137 till its level becomes equal to that of the **10 kHz BAND WIDTH**.

4-9-2 Adjustment of REFERENCE LEVEL 10 dB, 20 dB, and 30 dB

1. Set the S.G. output to 10.700 MHz, −10 dBm and connect it to the IF-II input (J296). Adjust the S.G. output level, so that the waveform peak comes to the center (**CENTER**) of the CRT display when the **VERT. MODE** is set to the **2 dB/DIV.** and the **BAND WIDTH** to **1 MHz**.
2. Adjust R123, so that the waveform peak comes to the center (**CENTER**) of the CRT display when the **REFERENCE LEVEL** is set to **−10 dBm** and the external attenuator to 10 dB.
3. Set the **REFERENCE LEVEL** to **−20 dBm** and the external attenuator to 20 dB and set the **REFERENCE LEVEL** to **−30 dBm** and the external attenuator to 30 dB. Then adjust R125 and R127 respectively till the waveform peaks come to the same level.
4. Adjust R74, so that the waveform peak comes to the −13 dBm level on the CRT display when the S.G. output level is set to −10 dBm and the external attenuator to 0 dB.
5. Set the **POWER** switch to **OFF** and return the board PK026 to its original position.

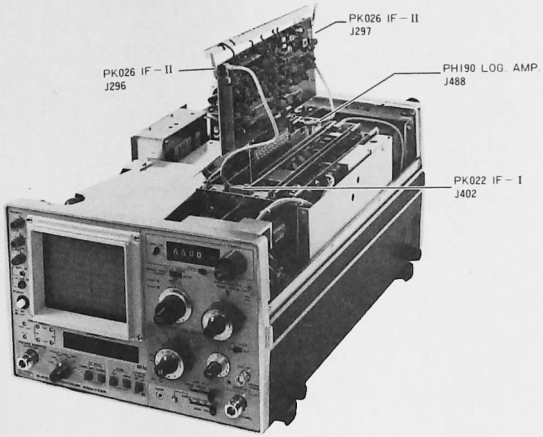


Fig. 4-17 IF-II Adjustment Setup

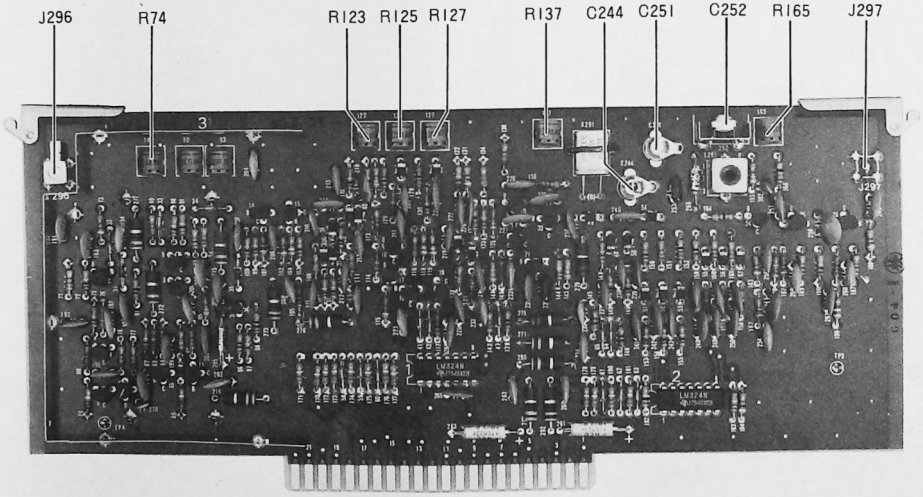


Fig. 4-18 Location of IF-II (PK026) Adjustment

4-10 IF-I Adjustment (Board code: PK022)

1. Set the **POWER** switch to **OFF** and pull out the board PK022.
2. Mount the board PK022 via the attached adjustment board **CY-822**.

4-10-1 Band Width Adjustment

1. Change the preliminary settings as follows:
   FREQUENCY ..... **10.70 MHz**
   COUNTER POWER ..... **ON**
   RESOL. ..... **1 kHz**
   T.G. MODE ..... **NORMAL**
   OUTPUT LEVEL ..... **–20 dBm**
   DISPERSION/DIV. ..... **1 MHz/DIV.**
   REFERENCE LEVEL ..... **–50 dBm**
2. Connect the **T.G.** output to the IF-I input (J401) and connect the IF-I output (J402) to the OG. AMP. input (J488). In this case, leave IF-II disconnected.
3. Set the **VERT. MODE** to the **2 dB/DIV.**, and turn the **TUNING** control till the **FREQUENCY COUNTER** LED shows 10.7 MHz ±30 kHz.
4. Set the **BAND WIDTH** to **3 MHz**, and adjust L371 to L375 till the band width at 3 dB down becomes 3.9 MHz to 4.2 MHz as shown in [Fig. 4-17].
5. Set the **BAND WIDTH** to **1 MHz**, and adjust C256, C259, C265, and C268 till the band width at 3 dB down becomes 1.3 MHz to 1.6 MHz. Keep C270 in the fully pulled-out condition.

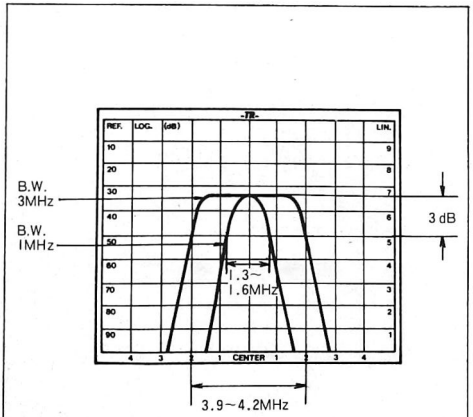


Fig. 4-20 Band Width Adjustment

4-10-2 Adjustment of Level Difference Between Band Widths

1. Connect the IF-I output (J402) with the IF-II input (J296) and the IF-II output (J297) with the LOG. AMP. input (J488) respectively by using the **MM-17** cable.
2. Set the S.G. output to 10.700 MHz, –2 dBm, and connect it to the IF-I input (J401).
3. Set the **VERT. MODE** to the **2 dB/DIV.**, the **BAND WIDTH** to **3 MHz**, and the **REFERENCE LEVEL** to **–10 dBm**. Turn the **REFERENCE LEVEL—FINE** control till the trace comes to the center (**CENTER**) of horizontal axis of the CRT display.
4. Adjust R99, so that the spectrum comes to the center of horizontal axis of the CRT display when the **BAND WIDTH** is set to **1 MHz**.
5. Adjust R122, so that the spectrum comes to the center of the horizontal axis on the CRT display when the **BAND WIDTH** is set to **100 kHz**.
6. Adjust R151, R169, and R187 respectively, so that the **BAND WIDTH** is set to **10 kHz**, **1 kHz**, and **0.5 kHz**.
7. Set the **POWER** switch to **OFF** and return the board PK022 to its original position.

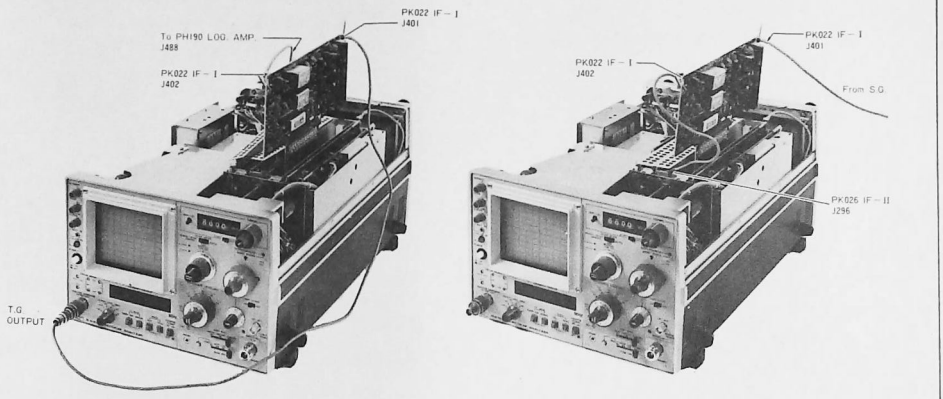


Fig. 4-19 IF-I Adjustment Setup

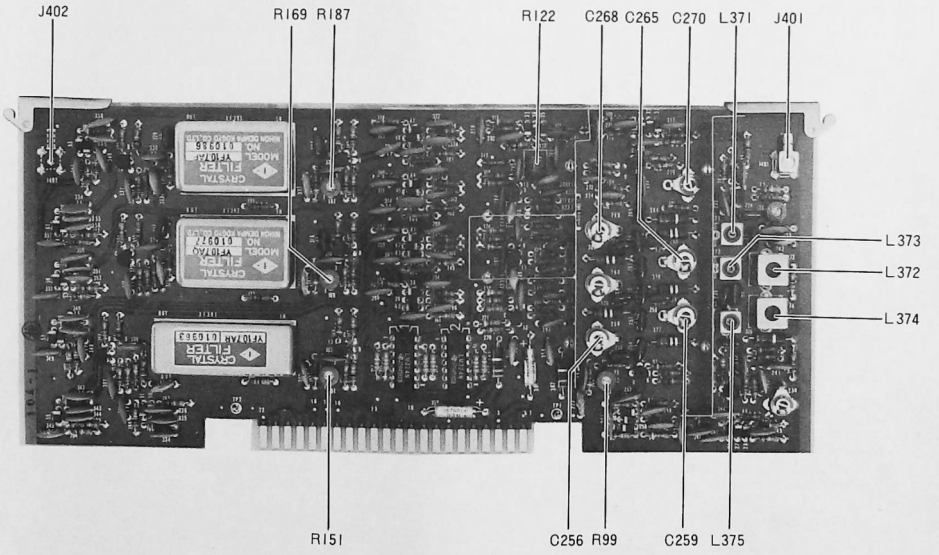


Fig. 4-21 Location of IF-I (PI022) Adjustment

4-11 RF Block Adjustment (MEP-255)

Equipment used: Spectrum analyzer
Signal generator (S.G.)
Power meter
Frequency counter

4-11-1 3rd Local Oscillator Adjustment

1. Connect the spectrum analyzer to the 3rd local output (J 3). Turn C175 till the oscillation spectrum (200 MHz, X'tal oscillation) becomes stabilized.
2. Connect the Frequency Counter to J3. Then, confirm the reading is within 200 MHz ±30 kHz.
3. Change the settings as follows to adjust the CAL. output level.
   TIME/DIV. ..... **10 ms/DIV.**
   DISPERSION/DIV. ..... **2 MHz/DIV.**
   BAND WIDTH ..... **1 MHz**
   REFERENCE LEVEL ..... **–20 dBm**
   VERT. MODE ..... **LINEAR**
4. Set the S.G. output to 200 MHz, –30 dBm, and carry out calibration using the frequency counter and power meter.
5. Connect the calibrated S.G. output to the **INPUT** connector of the instrument via the attached connection cable (**MC-61**) with the conversion adaptor.
   Turn the **REFERENCE LEVEL—FINE** control till the waveform peak comes to the topmost line on the CRT display.
6. Use the same cable and connect the **CAL. OUT.** connector with the **INPUT** connector of the instrument.
   Adjust R95 till the waveform peak comes to the topmost line on the CRT display.

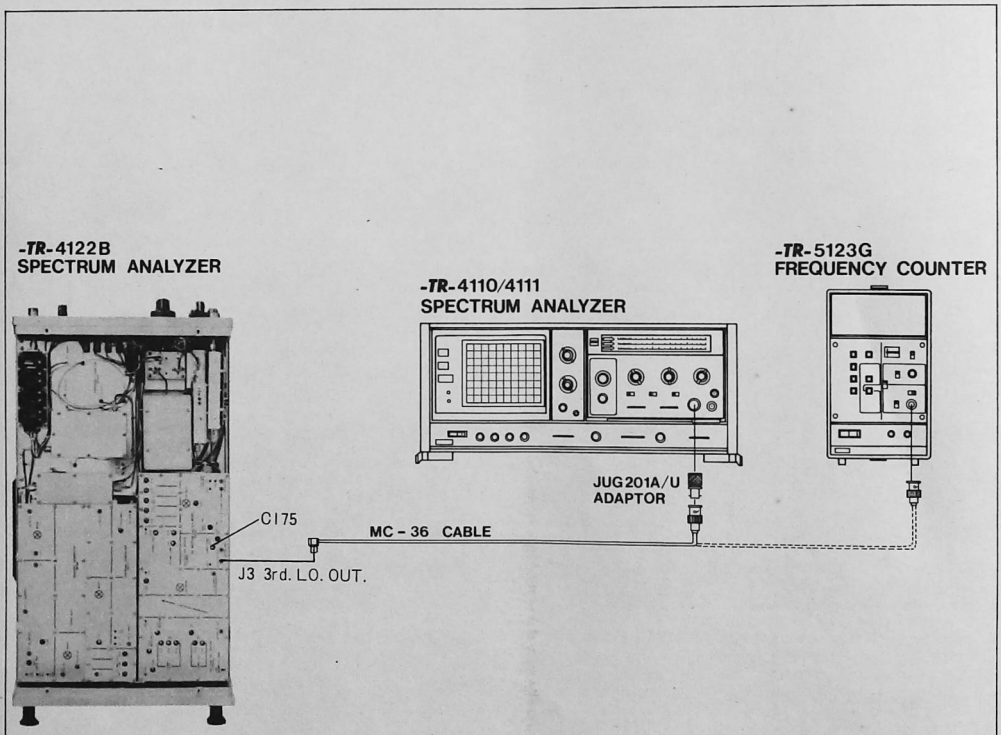


Fig. 4-22 RF SECTION (MEP-255) Adjustment Setup

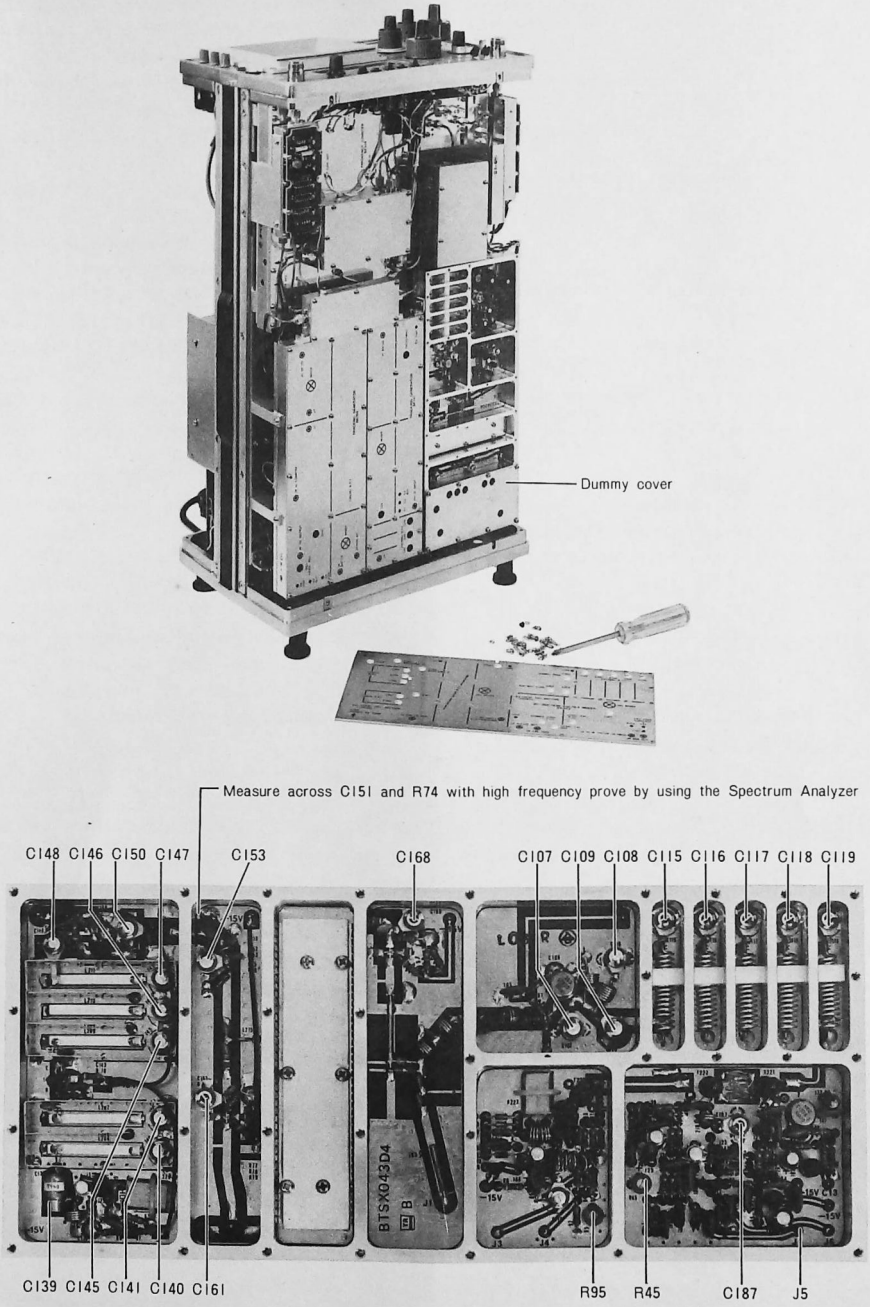

Dummy cover
Measure across C151 and R74 with high frequency prove by using the Spectrum Analyzer
C148 C146 C150 C147
C153
C168
C107 C109 C108 C115 C116 C117 C118 C119
C139 C145 C141 C140 C161
R95 R45 C187 J5

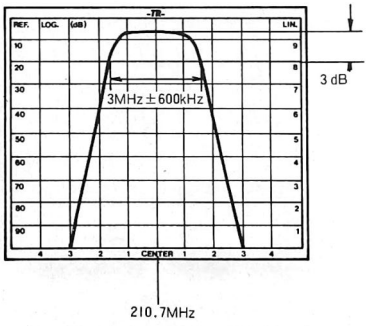
Fig. 4-23 2nd Local Oscillator Adjustment

4-11-2 2nd Local Oscillator Adjustment

1. Remove the cover from the RF block (MEP-255). As shown in [Fig. 4-23], place a dummy cover on the 2nd local oscillator section. (Note that the oscillation characteristics vary depending on whether the cover is placed or not. Be sure to place the cover before starting the adjustment.)
2. Measure across C151 and R74 with a high frequency probe by using the spectrum analyzer.
3. Turn C140, C141, C145 to C148 to a point approximately in the middle of the turning angle, and adjust by C139 so that the oscillation starts at 613.33 MHz. In this case, turn C139 to the middle position in the oscillation range (middle of turning angle). Take sufficient care not to turn C140 and C139 if not necessary.
4. Turn C140, C141, C145 to C148, and C150 to adjust the signal to the maximum level.
5. Turn C139 again and make sure that it is in the middle of the oscillation range (turning angle).
6. Connect the spectrum analyzer to the 2nd local output (J2, T.G. OUT.).
   Turn C153 and C161 to the maximum level for 1.84 GHz. The 2nd local (J2) outputs a signal of more than 1.84 GHz, 0 dBm.
   When the above adjustment has been done, replace the cover on the RF block.
7. Connect the **CAL. OUT.** connector with the **INPUT** connector, and turn the **TUNING** control till the signal comes to the center (**CENTER**) of the CRT display.
8. Set the **VERT. MODE** to the **10 dB/DIV.**, and adjust C168 till the 200 MHz CAL. signal comes to the highest level of the CRT display.

4-11-3 210.7 MHz IF Adjustment

1. Set the S.G. output to 200 MHz, −10 dBm, and connect it to the **INPUT** connector.
2. Change the preliminary settings as follows, and turn the **TUNING** control till the waveform comes to the center of the CRT display:
   DISPERSION/DIV. ..... **1 MHz/DIV.**
   BAND WIDTH ..... **3 MHz**
   VERT. MODE ..... **2 dB/DIV.**
3. Turn C107, C109, C115 to C119, so that the band width at 3 dB down becomes 3 MHz ±600 kHz.
4. Change the setting of the **VERT. MODE** to **10 dB/DIV.** and the **DISPERSION/DIV.** to **10 MHz/DIV.** Adjust C108 till the 189.3 MHz spurious response at 21 MHz to the left of the CRT display center disappears.
5. Since C107, C109, C115 to C119, and C108 are related to each other, repeat operations 2 to 4.



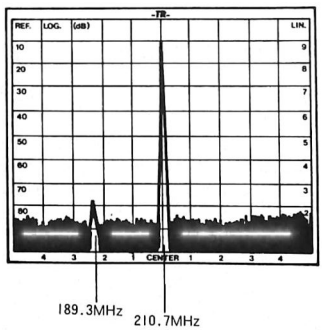


Fig. 4-24 210.7 MHz IF Adjustment

4-11-4 10.7 MHz IF Adjustment

1. Connect the **CAL. OUT.** connector with the **INPUT** connector, and turn the **TUNING** control till the signal comes to the center (**CENTER**) of the CRT display.
2. Turn C187 to obtain the max. level of the 200 MHz CAL. signal.
3. Cancel the CAL. signal, and feed the 10.7 MHz, –20 dBm signal from the signal generator to the **INPUT** connector. Set the **BAND WIDTH** to **3 MHz** and the **DISPERSION/DIV.** to the **1 MHz/DIV.**, and turn the **TUNING** control till the waveform comes to the center of the CRT display.
4. Set the **SCAN MODE** to **MANUAL SWEEP**, and make the marker point coincide with the waveform peak.
5. Connect J5 of the RF block to the spectrum analyzer and observe the 10.7 MHz signal. Adjust R45, so that the 10.7 MHz signal level becomes –20 dBm.

4-12 Tracking Generator Section Adjustment

Equipment used: Power Meter

4-12-1 Adjustment of 210.7 B.P.F. (Band-Pass Filter)

1. Connect the **CAL. OUT** connector and the **INPUT** connector via the attached connection cable (**MC-61**).
2. Change the preliminary settings as follows.
   BAND WIDTH . . . . . **3 MHz**
   VIDEO FILTER . . . . . **OFF**
   T.G. MODE . . . . . **TUNED AMP.**
3. Set the **DISPERSION/DIV.** to **1 MHz/DIV.** and turn the **TUNING** control till the signal comes to the center (**CENTER**) of the CRT display.
4. Operate **MANUAL SWEEP** control to shift the marker point to a point left of the waveform and higher by 15 dB than the noise level peak value. [Fig. 4-25]
5. Adjust C74, C79 to C81 so that the **FREQUENCY COUNTER** indicates 200.0 MHz (to function TUNED AMP.).
6. Then shift the marker point to a point right of waveform and higher by 15 dB than the noise level peak value. Readjust C74, C79 to C81 so that the **FREQUENCY COUNTER** indicates 200.0 MHz.
7. Repeat procedures 4 to 6 till the **FREQUENCY COUNTER** indicates the same frequency at any point on the waveform 15 dB above noise level.

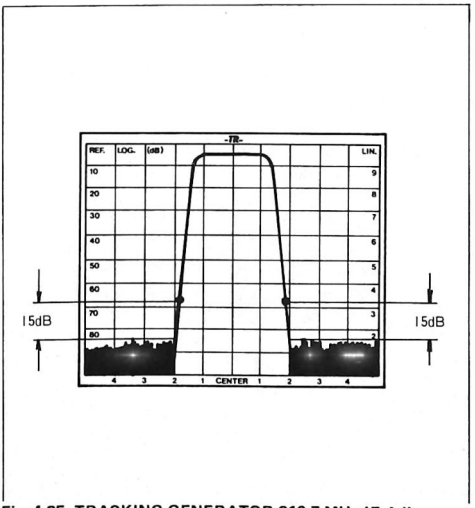


Fig. 4-25 TRACKING GENERATOR 210.7 MHz IF Adjustment

4-12-2 10.7 MHz Adjustment

1. Connect the **TRACKING GENERATOR OUTPUT** connector and **INPUT** connector. In this case, set the **OUTPUT LEVEL** to **-20 dBm**.
2. Change the preliminary settings as follows:
   SCAN MODE ..... **MANUAL SWEEP**
   BAND WIDTH ..... **1 kHz**
3. Set the marker point to the center of the CRT display by the **MANUAL SWEEP** control. Adjust C61 till the highest level is obtained.

4-12-3 Output Level Adjustment

1. Connect the power meter to the **TRACKING GENERATOR OUTPUT** connector.
2. Change the preliminary settings as follows:
   TIME/DIV. ..... **10 ms/DIV.**
   DISPERSION/DIV. **0**
   BAND WIDTH ..... **3 MHz**
   OUTPUT LEVEL ..... **0 dB**
3. Set the **FREQUENCY** to **200 MHz**. Adjust R53, so that the power meter indicates 0 dB ±0.5 dB.
4. Set the **FREQUENCY** to **1500 MHz**. Adjust C110, so that the power meter indicates the highest scale.
5. Turn the **TUNING** dial slowly to change the center frequency from 400 kHz to 1500 MHz, and make sure that the frequency characteristic is within ±1 dB.

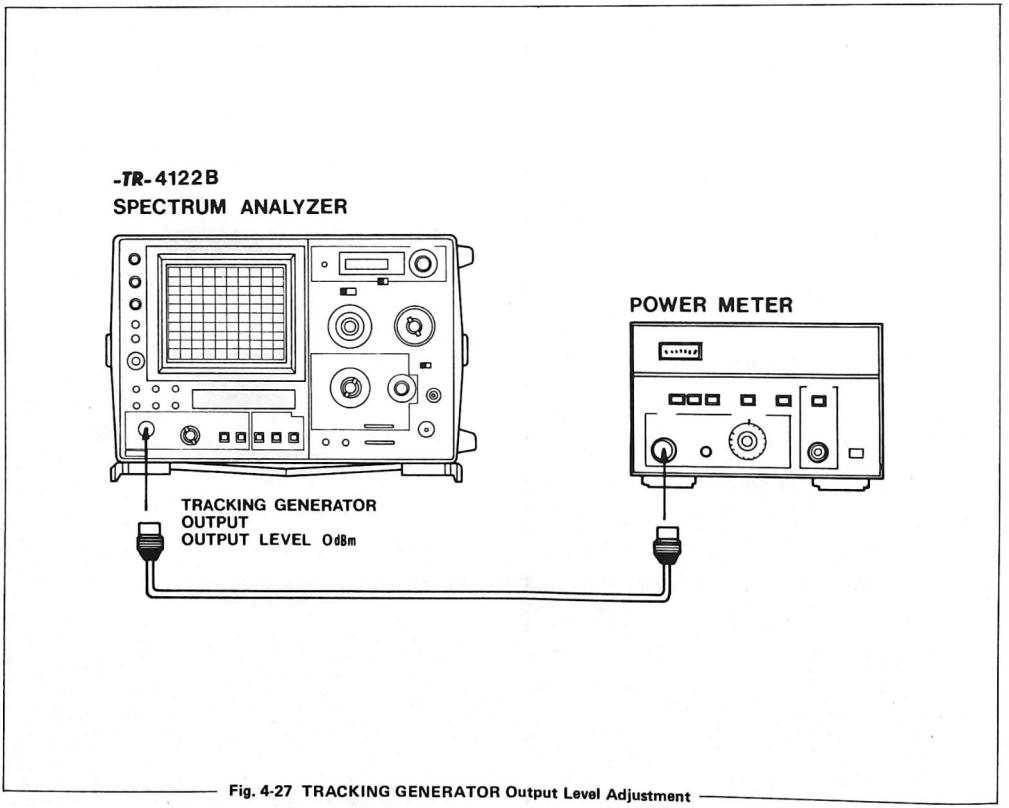


Fig. 4-27 TRACKING GENERATOR Output Level Adjustment

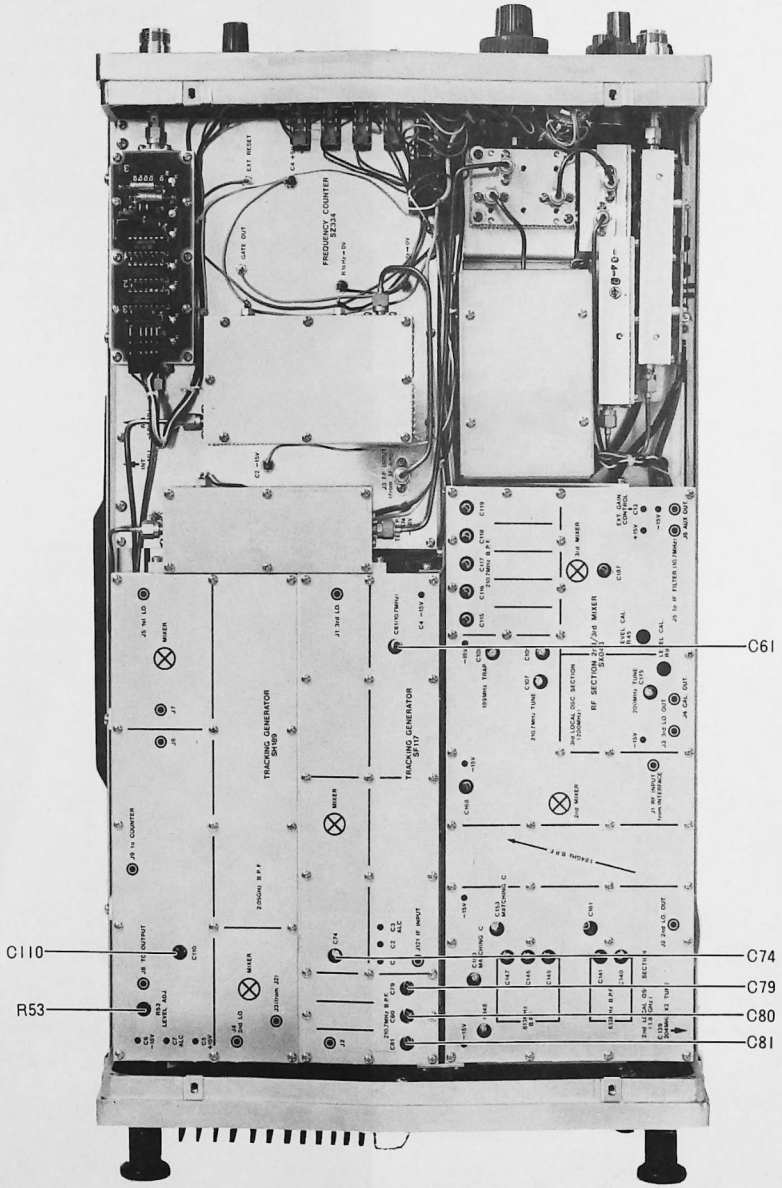


Fig. 4-26 Location of TRACKING GENERATOR Adjustment

4-13 Frequency Counter Adjustment

Equipment used: Frequency Counter
High-stability Signal Generator (S.G.)
Digital Voltmeter

1. Connect the digital voltmeter to TEST P. R74 −1.8 V, and adjust R74, so that the voltmeter indicates −1.80 V.
2. Connect external frequency counter (more than 5 x 10^{-8}/day) to S.G., and set the output frequency to 1000.0000 MHz.
3. Feed the S.G. signal corrected in para. 2 to the **INPUT** connector of the instrument. Turn the **TUNING** control till the signal comes to the center (**CENTER**) of the CRT display.
4. Set **T.G. MODE** to **TUNED AMP.** Set the **COUNTER POWER** to **ON** and **RESOL.** to **100 Hz**. Set the marker point to the waveform peak by the **MANUAL SWEEP** control.
5. Adjust C170 so that the **FREQUENCY COUNTER** indicates within 1000.0000 MHz + 5 counts.

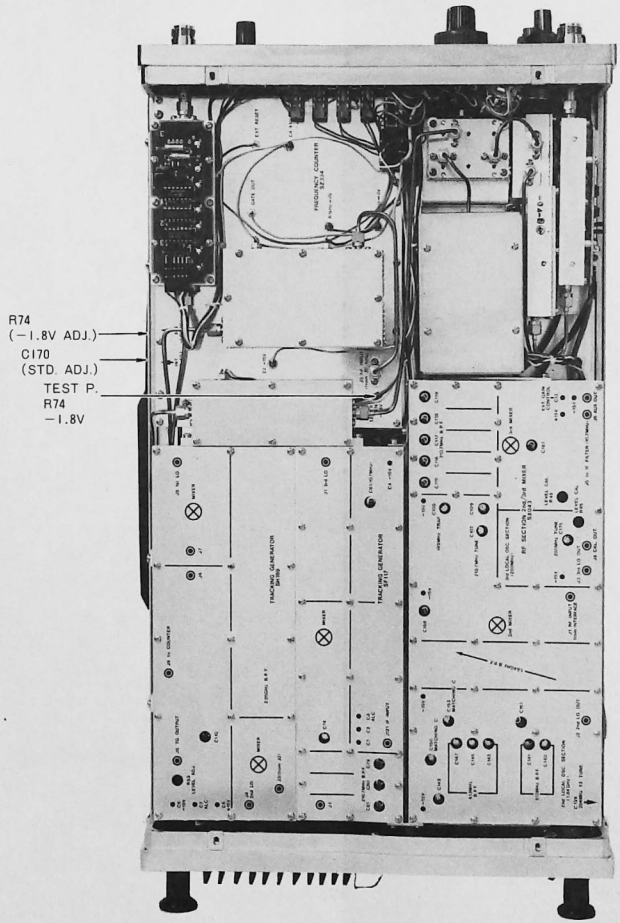


Fig. 4-28 Location of FREQUENCY COUNTER Adjustment

Table 4-4 CALIBRATION ADJUSTMENT CHECK LIST Serial No. _____

Preliminary Control Settings

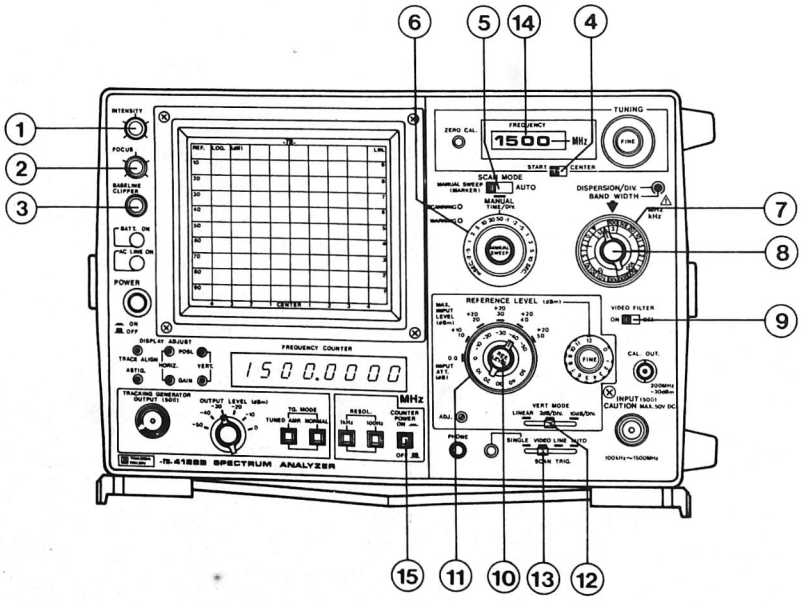
1). Set **POWER MODE** on the rear panel to **AC** and set **POWER** on the front panel to **OFF.** Connect the power cable of the instrument to the **AC** power source.

2) Set the front panel controls as follows:

1. **INTENSITY** ..... CENTER
2. **FOCUS** ..... CENTER
3. **BASELINE CLIPPER** ..... Counterclockwise to limit
4. **START/CENTER** ..... **CENTER**
5. **SCAN MODE** ..... **MANUAL**
6. **TIME/DIV.** ..... **5ms/DIV.**
7. **DISPERSION/DIV.** ..... **100MHz/DIV.**
8. **BAND WIDTH** **1MHz**
9. **VIDEO FILTER** ..... **OFF**
10. **REFERENCE LEVEL** ..... **0 dBm**
11. **INPUT ATT.** ..... **0 dB**
12. **VERT. MODE** ..... **10dB/DIV.**
13. **SCAN TRIG.** ..... **AUTO**
14. **FREQUENCY** **200MHz**
15. **COUNTER POWER** ..... **OFF**

3) With the **POWER** switch **OFF**, measure the impedance at the test point of board SE 160.

4) Set **POWER** switch to **ON**, warm up the instrument for about one hour.



	Adjustment and Check	Checking Point	Specifications				
1	Power Supply (Board SE160)	TP-1 (R39) TP-2 (R32) TP-3 TP-4 (R25) TP-5 (R22) TP-6	Impedance Voltage ∞ + 150V ∞ + 28.0V approx. 102Ω + 5V approx. 184Ω − 15.00V approx. 64Ω + 15.00V 0 0				
2	High Voltage-Power Supply (CRT Socket, Anode Connector)	Pin 10, 11 Pin 12 Pin 13 Pin 14 Anode	−1.5 kV approx. −1.52 kV to −1.60 kV −1.50 kV approx. −1.11 kV to −1.42 kV + 5kV				
3	CRT Driver (Board SG178)	R176 ASTIG. R178 R83, VERT. POSI., VERT. GAIN, R89, R111, R253 HORIZ. POSI.	INTENSITY adjustment FOCUS adjustment Distortion of the waveform adj. Vertical axis adjustment Horizontal axis adjustment				
4	YIG Driver (Board PG177)	TP-2 (R110) JI-11B (R121) R175, R196 R86, R83 R128	+ 10.00V adjustment − 5.00V adjustment Scan Lineality adjustment Dial scale accuracy adjustment START/CENTER switch adjustment				
5	Ramp Generator (Board PF119)	TP-2 (R72) R144, R78, R81	+ 10.00V adjustment Scan time adjustment				
6	LOG. AMP. (Board PH190)	R298 R240, R261, C400, R264 R243, R191 R246, R248	Linear adjustment LOG. linearity adjustment LINEAR linearity adjustment LOG. adjustment				
7	IF-II (Board PK026)	C252, C251, C244, R165 R137 R123, R125, R127, R74	Adjustment of the 10kHz BAND WIDTH symmetry REF. LEVEL 10, 20, 30dB adjustment				
8	IF-I (Board PK022)	L371 to L375, C256, C259 C265, C268, C270 R99 (B.W. 1 MHz) R122 (B.W. 100 kHz) R151 (B.W. 10 kHz) R169 (B.W. 1 kHz) R187 (B.W. 0.5 kHz)	Band Width adjustment Adjustment of level difference between band width				
9	RF Block (MEP-255)	C175, R95 C140, C141, C145 to 148 C139, C150, C153, C161, C168 C107, C109, C115 to 119, C108 C187, R45	3rd Lo. OSC. adjustment 2nd Lo. OSC. adjustment 210.7 MHz IF adjustment 10.7 MHz IF adjustment				
10	Tracking Generator (MEP-257)	C74, C79 to C81 C61 R53, C110	210.7 MHz B.P.F. adjustment 10.7 MHz adjustment Output level adjustment				
11	Frequency Counter (MEP-260)	TEST P. R74 C170	−1.80 V 1000.0000 MHz ± 5 counts				

CHAPTER 5
OPERATION PRINCIPLES

5-1 General

This Chapter describes the outline of the general construction of the **-TR-4122B** Spectrum Analyzer and the function of each section. Detailed circuit diagrams are attached to the end of this manual. For the terms and special parts, please refer to "Technical Terms."

This Chapter is intended for specialists in electronic engineering.

5-2 General Construction

The Spectrum analyzer is a heterodyne receiver: the input signal is converted to a fixed intermediate frequency (IF) which is used for the signal separation and level reading. This instrument incorporates a tracking generator (a signal generator generating a frequency signal corresponding to that of the input signal) and frequency counter.

The signal fed to the input of **-TR-4122B** enters first into the 1st mixer. Here the signal is mixed with the signal from the 1st local oscillator and upward-converted to 2.05 GHz. The YIG tuned oscillator is used as the 1st local oscillator, performing a sweep over the range up to a max. 2 GHz to 3.5 GHz. The 2.05 GHz IF signal passes through the interface (MEP-254) and enters the RF section (MEP-255).

Here two mixers downward-converts the signal to the final 10.7 MHz intermediate frequency. This 10.7 MHz IF signal is subject to the selection of a proper bandwidth by the IF filter section and enters LOG. AMP. section. Here the logarithmic approximation is made and the signal is converted into DC voltage corresponding to IF signal amplitude by the detector and displayed on the CRT. [Fig. 5-1] shows the general construction.

5-3 Description of Each Section

5-3-1 DC CUT-OFF Section

The input connector incorporates the capacitor to cut the DC signal component.

5-3-2 RF ATTENUATOR, T.G. ATTENUATOR Section

The RF attenuator **(INPUT ATT.)** and T.G. attenuator **(OUTPUT ATT.)** are programmable attenuators using relays. Attenuation is made from 0 dB to 50 dB in 10 dB steps. [Fig. 5-2] shows the attenuator construction and the relationship between the relay and attenuation characteristics.

5-3-3 1st MIXER Section (MEP-253)

The input L.P.F. (Low Pass Filter) and mixer make up this section to convert the input signal into the 1st IF signal.

1. Low Pass Filter

A string Chebyshev filters in 15 stages made up of balanced strip lines.

2. 1st Mixer

The double-balanced type mixer determines the input frequency flatness characteristics and harmony distortion of the spectrum analyzer.

Input frequency:	0 to 1500 MHz
Local oscillation frequency:	2 GHz to 3.5 GHz (+12 dBm)
Intermediate frequency:	2.05 GHz

5-3-4 INTERFACE Section (MEP-254)

The connects the 1st mixer section to the 2nd mixer in the RF section, comprising a traveling wave coupler filter, L.P.F., amplifier, and B.P.F.

1. Traveling Wave Coupler Filter

A one-wavelength resonator for the 2.05 GHz 1st IF signal, with a 50 Ω terminal for other frequencies.

2. 2.05 GHz Low Pass Filter

This comprises a balanced strip line, attenuating the frequency above 2.05 GHz.

3. 2.05 GHz AMP.

This compensates the loss of the next stage to improve the max. input sensitivity of the spectrum analyzer. To cover the loss of about 10 dB in the next stage, this has an amplifying gain of about 12 dB.

4. 2.05 GHz Band Pass Filter

This removes all spurious components of the signal to prevent the generation of a spurious response in the 2nd mixer. This is comprised of five stages of a half-wavelength of the balanced strip line.

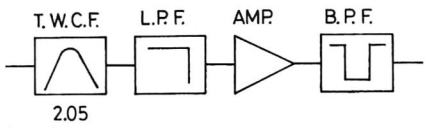


Fig. 5-3 INTERFACE Section Block Diagram

5-3-5 RF BLOCK Section (MEP-255)

This converts the 2.05 GHz 1st IF signal from the interface into a final IF signal of 10.7 MHz, comprising the 2nd local OSC, 2nd mixer, 2nd IF, 3rd local OSC., 3rd mixer, and 3rd IF.

1. 2nd Local OSC.

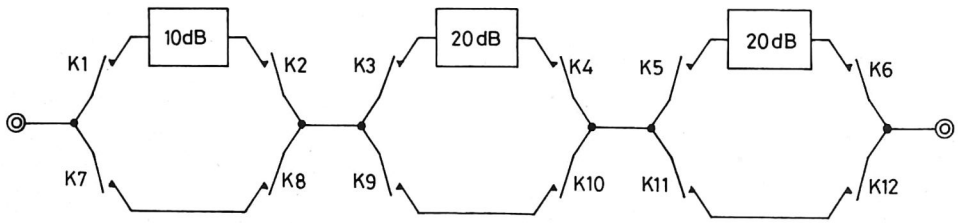
This oscillator is made up from a 204.4 MHz special Colpitts circuits and 3rd harmonics collector tuning circuit.

Since the turning is made on the collector side, the 3rd harmonics can effectively be taken. Frequency components other than 613.3 MHz are attenuated in B.P.F. to prevent spurious response. A 613.3 MHz signal is tripled and amplified to an adequate level for the driving of the mixer.

The multi up circuit is a parallel self-bias type using S.R.D. (step recovering diode).

2. 2nd Mixer

A single balanced mixer, producing 210 MHz by mixing 2.05 GHz input (RF) and 2nd LO 1.84 GHz.



	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12
0dB	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON
10dB	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON
20dB	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
30dB	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF
40dB	OFF	OFF	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF	OFF
50dB	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF

Fig. 5-2 Composition of Attenuator

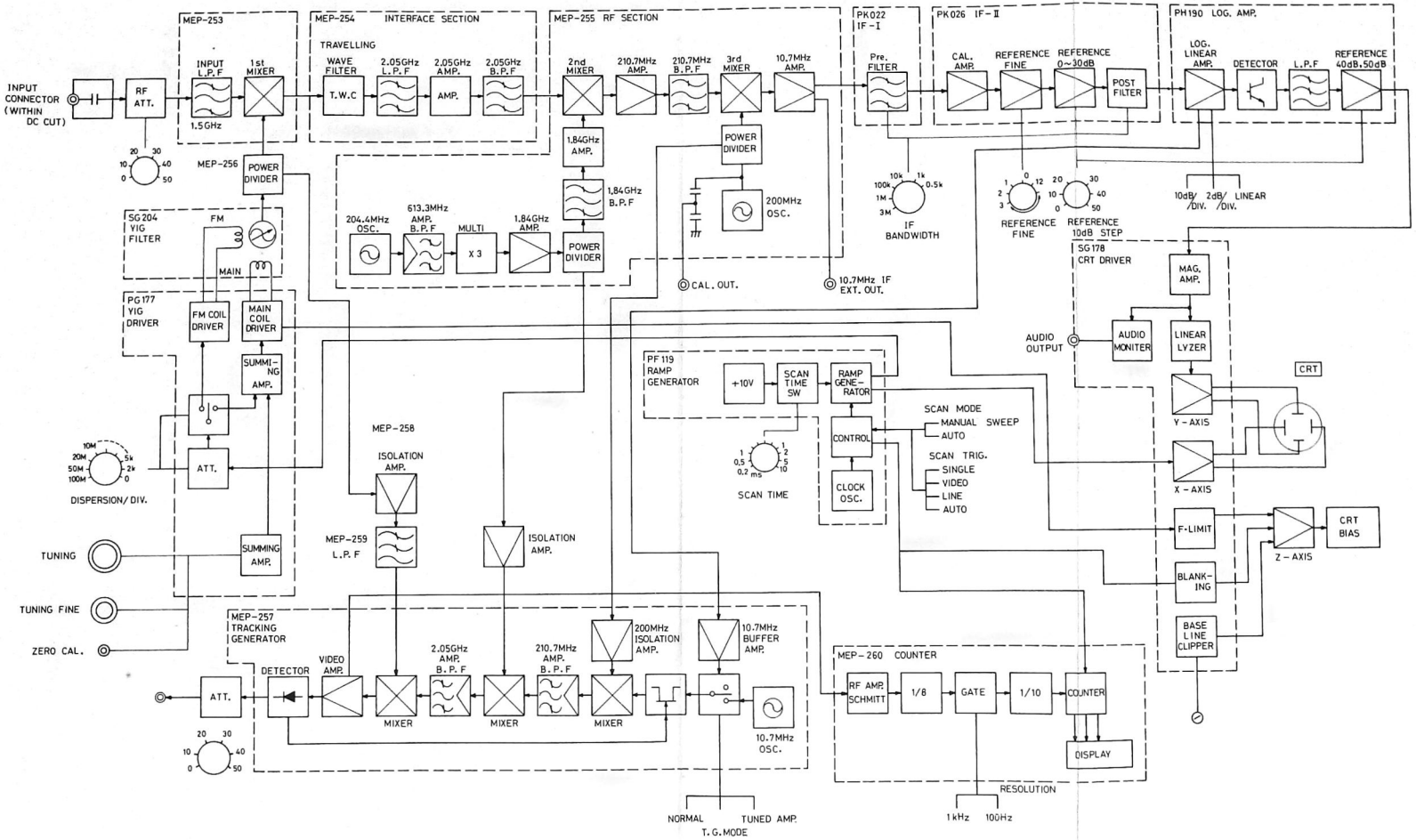


Fig. 5-1

-TR-4122B BLOCK DIAGRAM

3. 2nd IF Section

This comprises a 210.7 MHz amplifier and a 210.7 MHz B.P.F. The amplifier compensates the loss of the next stage to improve the max. input sensitivity of the instrument. B.P.F. is made up of five stages of the coupled resonator filters to obtain attenuation of more than 100 dB for 189.3 MHz {210.7 – (10.7 x 2)} (equal to double the IF signal (10.7 MHz).

4. 3rd Mixer, 3rd IF Section

The double balanced mixer, producing 10.7 MHz by mixing RF 210.7 MHz and the 3rd LO 200 MHz. In the 3rd IF, R45 is adjusted to obtain constant gain, and RF interchangeability is ensured.

The 3rd LO is a Colpitts oscillator, which has high level stability because this is used also to generate the CAL (calibration) signal.

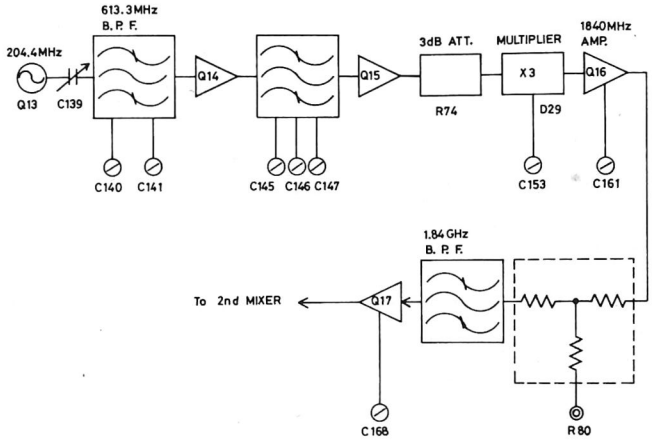


Fig. 5-4 2nd Local OSC. Section Block Diagram

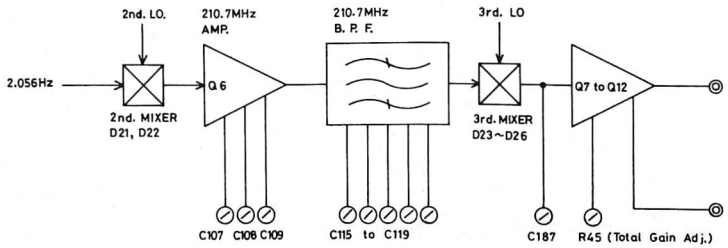


Fig. 5-5 RF Section Block Diagram

5-3-6 IF 1st Stage Section (PK022)

The resolution bandwidth of the instrument is determined by IF-1st stage and IF-2nd stage sections. IF-1st stage is a rectangular filter, principally determining the lower characteristics of the resolution bandwidth filter.

1. Construction

L and C are used for 3 MHz and 1 MHz B.P.F., ceramic for 100 kHz B.P.F., and X'tal for 10 kHz, 1 kHz, and 0.5 kHz B.P.F. Each switch is a diode switch, ensuring sufficient isolation. [Fig. 5-6] shows the construction and [Table 5-1] the relationship between the resolution bandwidth (**BAND WIDTH**) and the switch.

2. Diode Switch Construction

Three diodes are used to ensure isolation. When V control terminal in [Fig. 5-7] reaches +15 V, diodes D1 and D3 are OFF, D2 ON, and the input and output terminals OFF.

When V control terminal reaches −15 V, D1 and D3 are ON, D2 OFF, and the input and output terminals are coupled.

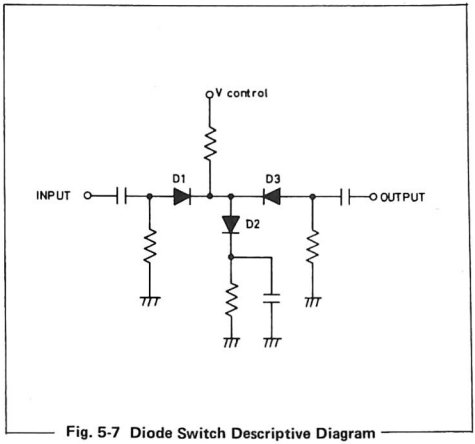


Fig. 5-7 Diode Switch Descriptive Diagram

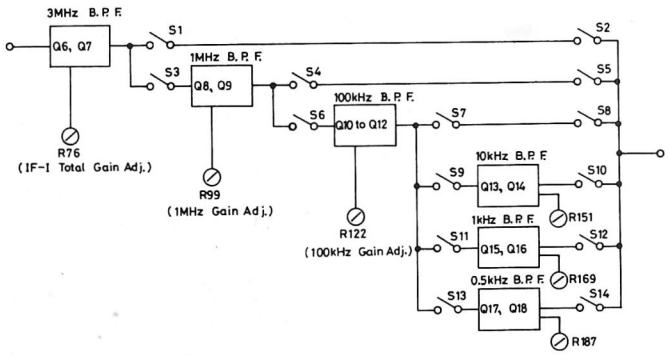


Fig. 5-6 IF-I Section Block Diagram

B. W	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
3MHz	○	○	×	×	×	×	×	×	×	×	×	×	×	×
1MHz	×	×	○	○	○	×	×	×	×	×	×	×	×	×
100kHz	×	×	○	×	×	○	○	○	×	×	×	×	×	×
10kHz	×	×	○	×	×	○	×	×	○	○	×	×	×	×
1kHz	×	×	○	×	×	○	×	×	×	×	○	○	×	×
0.5kHz	×	×	○	×	×	○	×	×	×	×	×	×	○	○

○ : ON × : OFF

Fig. 5-1 Status of Switches at each BAND WIDTH Selection

3. Filter Construction

Each filter has an impedance conversion amplifier and filter loss compensating amplifier on the input side and an output buffer amplifier (0 dB gain) on the output side. Input amplifiers have an output impedance of 470 Ω (330 Ω for ceramic filter) while the output buffer amplifier an output impedance of 220 Ω. Refer to [Fig. 5-8].

5-3-7 IF 2nd Stage Section (PK026)

This comprises a calibration amplifier, 0 to 12 dB variable gain amplifier, step amplifier, and filter.

1. CAL. AMP. Section

The **REFERENCE LEVEL ADJ.** control on the front panel is connected to this amplifier. [Fig. 5-9] shows the amplifier construction. D31 is a pin diode and R74 changes bias current to change the amplifier gain.

2. 0 dB to 12 dB Variable Gain Amplifier

The **REFERENCE LEVEL—FINE** control on the front panel controls the gain of this amplifier. This is an attenuator using a pin diode and is variable from 3 dB to 15 dB by the **REFERENCE LEVEL—FINE** control. Q12 and Q13, Q90 and Q93 determine the variable range of bias current. Q10 and Q11 have a lower impedance relative to this attenuator while Q14 and Q15 a higher impedance.

3. REFERENCE LEVEL –10, –20, and –30 dBm

The **REFERENCE LEVEL** switch on the front panel determines –10, –20, and –30 dB in 10 dB steps. [Fig. 5-10] shows the circuit construction.

All switches are diode switches. The number of diodes in the switches is increased according to the required isolation: 3 diodes for S1, 2 for S2 and S3, 1 for S4 and S5. Due to increased amplitude, the output incorporates a complementary circuit.

When the **REFERENCE LEVEL** switch is set to **0 dBm**, only S1 is turned ON and the input is output as it is. When the switch is set to **–10 dBm**, S1 is turned OFF and S2 and S3 ON, the amplification increases by 10 dB according to the ratio between R123 and R115. When the switch is set to **–20 dBm**, S4 is also turned ON, and amplification increases to 20 dB at R125. When the switch is set to **–30 dBm**, S5 is also turned ON, increasing amplification to 30 dB at R127.

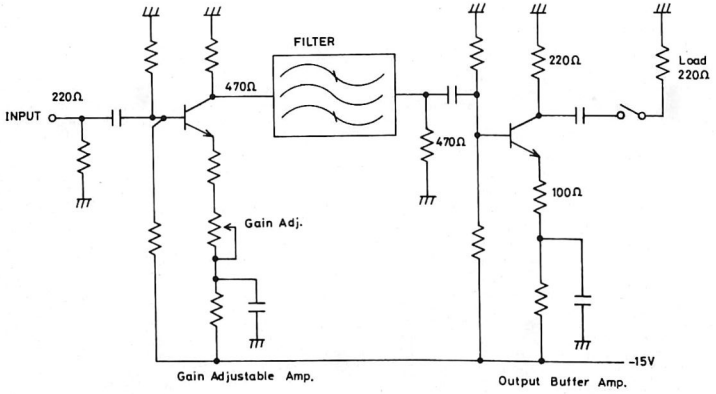


Fig. 5-8 IF-I Filter Descriptive Diagram

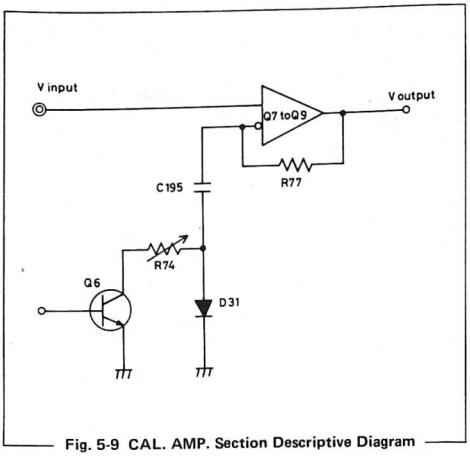


Fig. 5-9 CAL. AMP. Section Descriptive Diagram

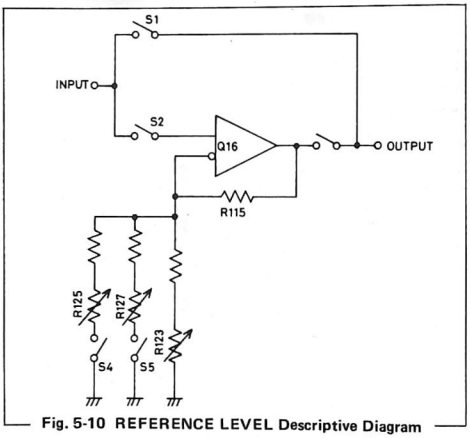


Fig. 5-10 REFERENCE LEVEL Descriptive Diagram

4. Filter Section

This determines principally the 3 dB bandwidth of the **BAND WIDTH**. **3 MHz**, **1 MHz**, and **100 kHz** are made up from R, L, and C. **10 kHz**, **1 kHz**, and **0.5 kHz** are made up from X'tal and R. Circuit construction is shown in Fig. 5-11. With the **BAND WIDTH** at **3 MHz**, **1 MHz**, and **100 kHz**, Q23 and D51 to D54 are OFF while D48 to D50 ON.

Fig. 5-12 gives a simplified illustration of the circuit construction.

From this circuit,

$$\frac{\Delta\omega}{\omega o}=\frac{1}{Q}=\frac{1}{4\,R}\sqrt{\frac{L}{C}}$$

Namely, the 3 dB bandwidth is determined by changing R.

With the **BAND WIDTH** at **3 MHz**, D55 goes ON. At **1 MHz**, D56 goes ON: D57 becomes ON with the **BAND WIDTH** at **100 kHz**. In either case, R159, R160, and R161 determine the 3 dB bandwidth.

With the **BAND WIDTH** at **10 kHz**, **1 kHz**, or **0.5 kHz**, Q23 and D54 ON while D48 to D50 go OFF. The circuit is shown roughly in [Fig. 5-13].

In this circuit, $\frac{1}{Q}=\frac{\Delta\omega}{\omega_0}=R\times\sqrt{\frac{Cs}{Ls}}$ the 3 dB bandwidth is determined by changing the R value.

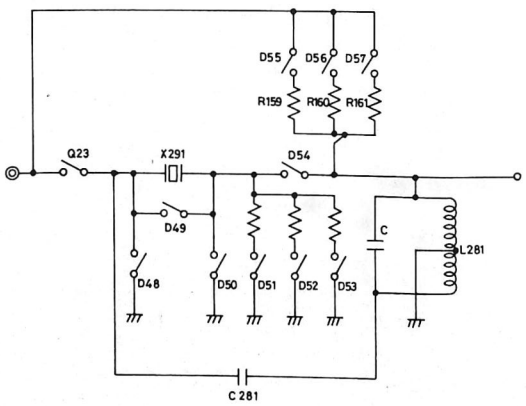


Fig. 5-11

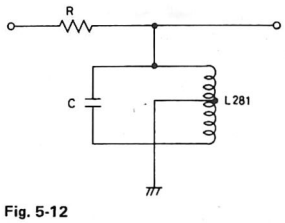


Fig. 5-12

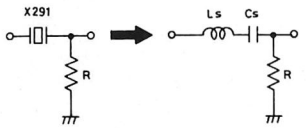


Fig. 5-13

Fig. 5-11/12/13 Post Filter Descriptive Diagram

5-3-8 LOG. AMP. Section (PH190)

The LOG. AMP. section consists of the linear amplifier, LOG. amplifier, detector, REFERENCE LEVEL –40 dBm, –50 dBm, step amplifier, and video filter. Refer to [Fig. 5-14].

1. Linear Amplifier

D517, D514, D516, D518, and D519 are OFF, and the gain of each amplifier is 1. In the first stage, the loss becomes 14 dB.

With the setting of **LINEAR**, the level becomes –7 dBm (100 mVrms at 50 Ω), which is equivalent to the top most position on the CRT display. Therefore, the gain at the 1st stage must be 21 dB including a loss of 14 dB.

For setting to **LINEAR**, D93, D94, and D95 are ON and a gain of 21 dB is obtained.

2. LOG. Amplifier

D517, D514, D516, D518, and D519 are ON, and the gain of each amplifier is 10 dB. D75 through D92 are Schottky barrier diodes and the ON resistance varies depending on the input level so as to make a logarithmic approximation of the amplifier gain. Each stage includes a summing amplifier.

3. Narrow-Wide Change-over

The LOG. amplifier must have a band width exceeding the 3 MHz IF band width. If its band width is too large, the noise of the LOG. amplifier appears on the screen and no change is obtained even if the IF filter in the previous stage is switched to a narrower band width. Accordingly, to prevent the noise of the LOG. amplifier from appearing on the CRT display, its band width is changed by **BAND WIDTH**. At 100 kHz or below, K487 is shifted to the **TUNED AMP.** side to obtain about a 1 MHz band width.

4. DETECTOR

Q37 performs the voltage and current conversion of the LOG. amplifier output. Q38 controlled by D97 and D98 functions as a detector. The output filter prevents the 10.7 MHz from being transmitted to the subsequent stage, and carries out attenuation of more than 60 dB for 10.7 MHz.

The video filter has a cut-off frequency equivalent to about 1/30 of the IF band width. Its capacity is switched according to the **BAND WIDTH**.

The output DC amplifier adjusts R261 and R240 so as to change +5 V at 0 dBm, +0.5 V at 10 dB change, 0 V at –100 dBm.

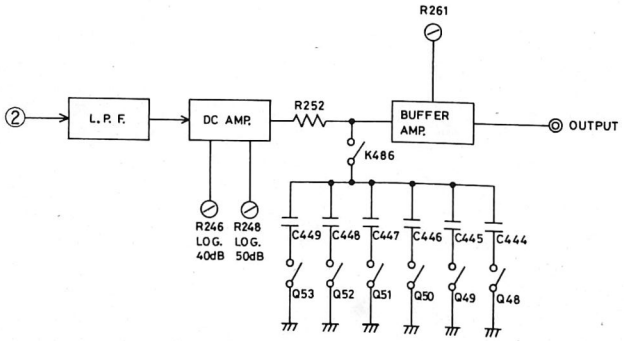


Fig. 5-14

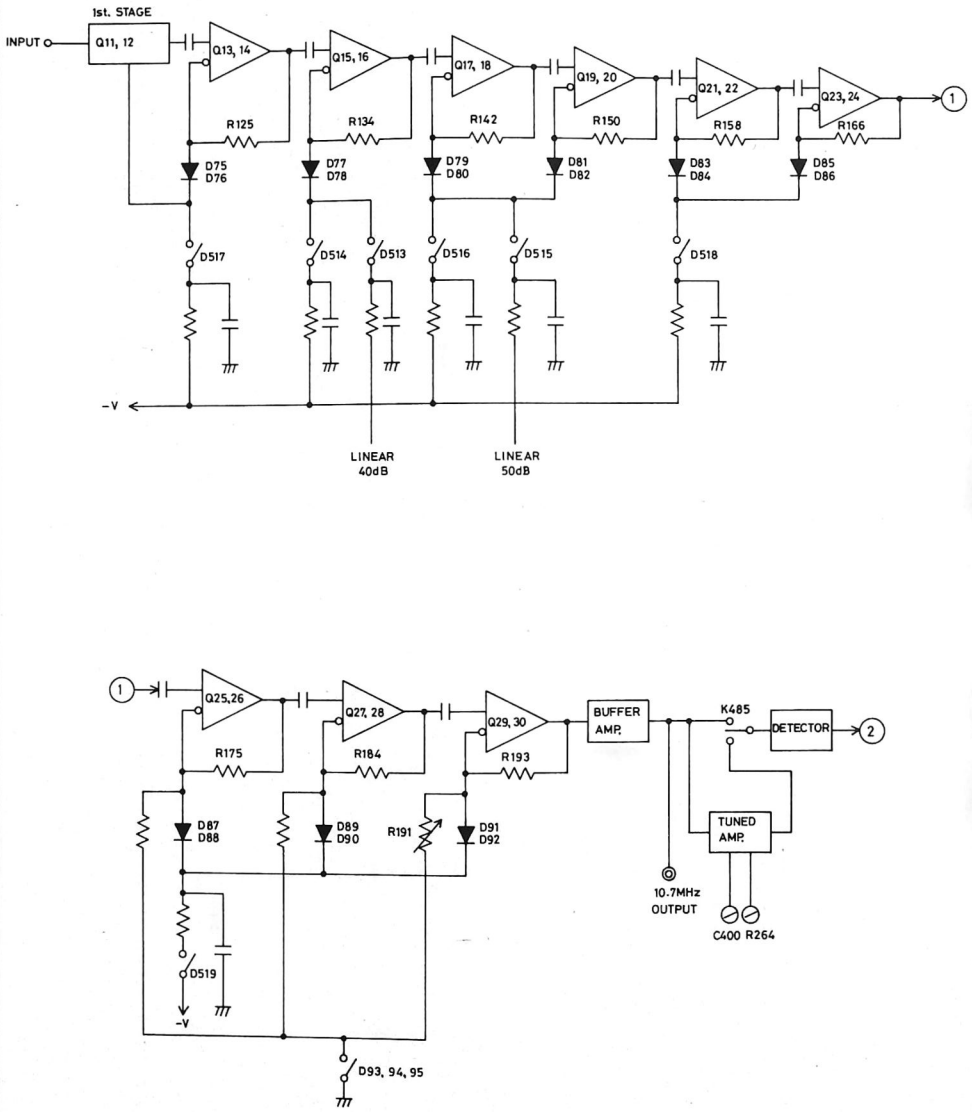


Fig. 5-14 LOG. AMP. Section Descriptive Diagram

5-3-9 CRT DRIVER Section (SG178)

The CRT driver is made up of the differential amplifier to bias the trace in X-axis and Y-axis directions, circuits to set the CRT grid voltage and bias voltage, and audio monitor.

1. Y-axis (vertical axis of the CRT display)

The output voltage from the LOG. amplifier is set to either **10 dB/DIV.** or **2 dB/DIV.** by the amplitude amplifier. When setting to **2 dB/DIV.**, Q12 is ON. Its output is output as the external Y-axis output and audio monitor output to the outside.

Input voltage ranges from 0 to 5 V, and the output voltage ranges about 66 V to 103 V for Y^+ and about 103 V to 66 V for Y^-.

2. X-axis (horizontal axis of the CRT display)

The ramp input voltage +5 V to −5 V is amplified to +140 V to +30 V for X^+ and +30 V to +140 V for X^-. Because of the lack of linearity unique to CRT, the 2-point linearizer is used for correction.

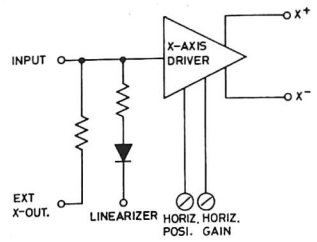


Fig. 5-16 CRT DRIVER X-Axis Section Descriptive Diagram

3. Z-axis (blanking)

This functions as a base line limiter, frequency limiter, and blanking. Z-output becomes 0 volts during blanking.

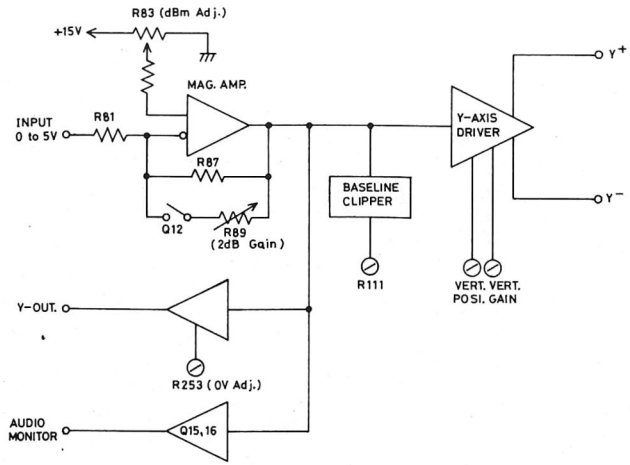


Fig. 5-15 CRT DRIVER Y-Axis Section Descriptive Diagram

5-3-10 YIG DRIVER Section (PG177)

This drives the oscillation frequency of the YIG oscillator (1st LO) and comprises the TUNING voltage, DISPERSION attenuator, YIG driver, +10 V and –5 V regulators.

1. Regulator

Except for the 1st LO YIG oscillator, all of the local oscillators of the instrument are X'tal oscillators, and thus the spectrum stability and purity depends on the YIG oscillator. Accordingly, the voltage to control the YIG oscillator must be kept very stable. The YIG oscillator produces the reference voltage by the +10 V regulator and outputs the tuning voltage.

2. Tuning voltage

Highly-stable and low-noise zener diode converts this +10 V into the reference voltage, which is further converted into the 0 to 1500 MHz (2.05 GHz to 3.55 GHz for YIG oscillator) TUNING voltage by the resistance division.

3. DISPERSION/DIV.

The ramp voltage from the ramp generator is set to a sweep width corresponding to the setting of the **DISPERSION/DIV.** on the front panel. Because of the high current sensitivity of the YIG oscillator main coil, a stable sweep is impossible. Therefore, the main coil makes only the tuning and the FM coil performs the sweep. The relationship of each switch to the **DISPERSION/DIV.** switch setting is shown in [Table 5-2].

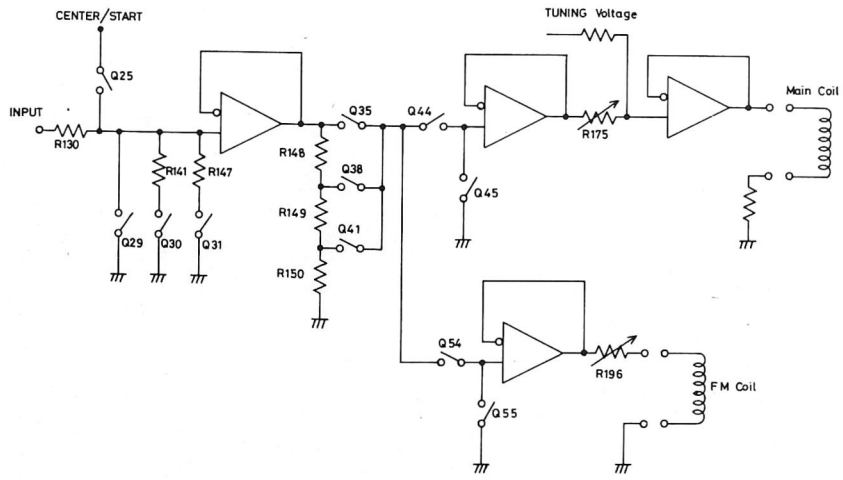


Fig. 5-17 YIG DRIVER Section Block Diagram

5-3-11 RAMP GENERATOR Section (PF119)

The ramp generator is made up of the ramp voltage generator, ramp voltage variable section (sweep time variable section), scan trigger, and control.

1. Ramp voltage generator, ramp voltage variable section

With Q61 OFF, the output voltage is varied according to the sweep time **(TIME/DIV.)** set by the combination from Q24 to Q27. In this case, the Q21 2/2 base voltage is stable at 10 V. Therefore, the Q21 2/2 emitter voltage changes to change the collector current. The collector current flows through C177 to be charged as expressed by the formula shown below:

$$V = \frac{Ict}{C177}$$

With V and C177 constant, t changes according to the Ic change.

IC3 functions as a comparator and is designed to be inverted when the rang voltage reaches V (V). When the IC3 output becomes negative as a result of inversion, D61 is ON, discharging the C177 charge voltage.

2. Scan Trigger and Control

To control IC6, the IC7 gate selects either **AUTO.** scan trigger, **LINE** scan trigger, **VIDEO** scan trigger, or **SINGLE** scan.

A sweep process example.

When TP-6 is "H" (High level), Q36 is ON, Q37 OFF, and Q38 ON. The output becomes "L" (Low level). IC6-6 is "L", IC7-1 "H", IC7-13 "L", IC6-9 "L", and IC6-12 (TP-6) "L", turning Q36 OFF and Q35 ON. Q38 is ON and keeps this condition. Since the Q35 collector voltage is ON, the voltage of the IC3-2 pin rises along with the increase in ramp voltage. When this voltage exceeds the voltage of the IC3-3 pin, the output of IC3 (comparator) is inverted to negative, turning Q35 OFF. Q37 is ON, and Q38 OFF. Then TP-6 becomes "H", and the above process is repeated.

3. Counter Operation

Manual voltage and ramp voltage pass through the IC5 comparator and drive the counter gate. While the gate is open, Q40 is ON and Q39 OFF. Manual voltage is output as the ramp voltage. When the gate closes, Q40 is OFF and Q39 ON. Ramp voltage is output.

DISPERSION/DIV.	Q29	Q30	Q31	Q35	Q38	Q41	Q44	Q45	Q54	Q55
100MHz	–	–	–	○	–	–	○	–	–	○
1MHz	–	–	–	○	–	–	–	○	○	–
50MHz	–	○	–	○	–	–	○	–	–	○
500 kHz	–	○	–	○	–	–	–	○	○	–
20MHz	–	–	○	○	–	–	○	–	–	○
200 kHz	–	–	○	○	–	–	–	○	○	–
10MHz	–	–	–	–	○	–	○	–	–	○
100 kHz	–	–	–	–	○	–	–	○	○	–
5MHz	–	○	–	–	○	–	○	–	–	○
50 kHz	–	○	–	–	○	–	–	○	○	–
2MHz	–	–	○	–	○	–	○	–	–	○
20 kHz	–	–	○	–	○	–	–	○	○	–
10 kHz	–	–	–	–	–	○	–	○	○	–
5 kHz	–	○	–	–	–	○	–	○	○	–
2 kHz	–	–	○	–	–	○	–	○	○	–
0	○	–	–	–	–	–	–	–	–	–

* Set the CENTER/START switch to START on the front panel. Q25 comes ON and a constant current flows through R130, and shifts the voltage. (With Q30 ON, the current flows R130 and R141 in parallel.)

○ : ON —— : OFF

Table 5-2 Status of Switches at each DISPERSION/DIV. Selection

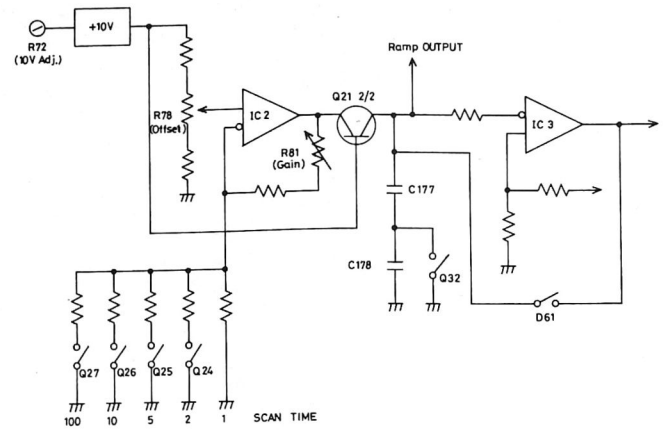


Fig. 5-18 Ramp Voltage Generator/Regulator Descriptive Diagram

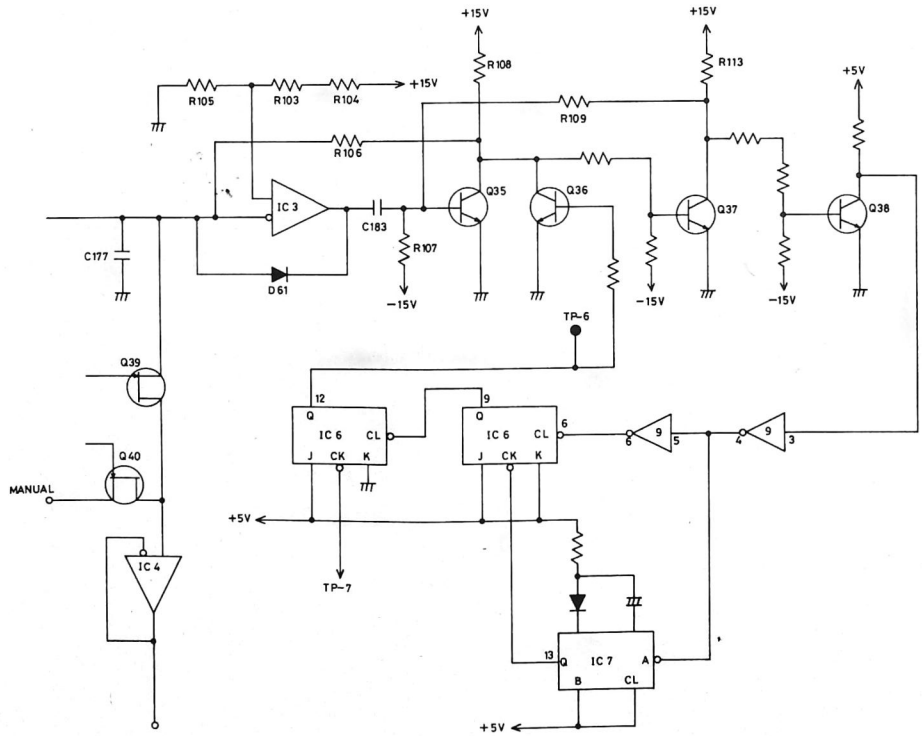


Fig. 5-19 Scan Trigger/Control Section Descriptive Diagram

5-3-12 TRACKING GENERATOR Section (MEP-257)

The spectrum analyzer uses three local amplifiers (YIG OSC. 2 to 3.5 GHz, 2nd LO 1840 MHz, 34d LO 200 MHz) to obtain the final IF signal of 10.7 MHz. Contrary to this, the tracking generator uses the above three local amplifiers to convert the 10.7 MHz into the input signal. Refer to [Fig. 5-20].

Set the **T.G. MODE** to **NORMAL**. The 10.7 MHz signal is fed from the X'tal oscillator. When the **T.G. MODE** is set to **TUNED AMP.**, the spectrum analyzer feeds the IF signal (LOG. AMP. output 10.7 MHz in this instrument).

To prevent unnecessary spectrum of the tracking generator from mixing into the spectrum analyzer, each local input is sufficiently isolated and fed into each amplifier of the tracking generator. ALC (automatic level control) feeds FET (Q3) to the 10.7 MHz signal line, and changes the level by varying the drain-source resistance through the control of the FET gate voltage.

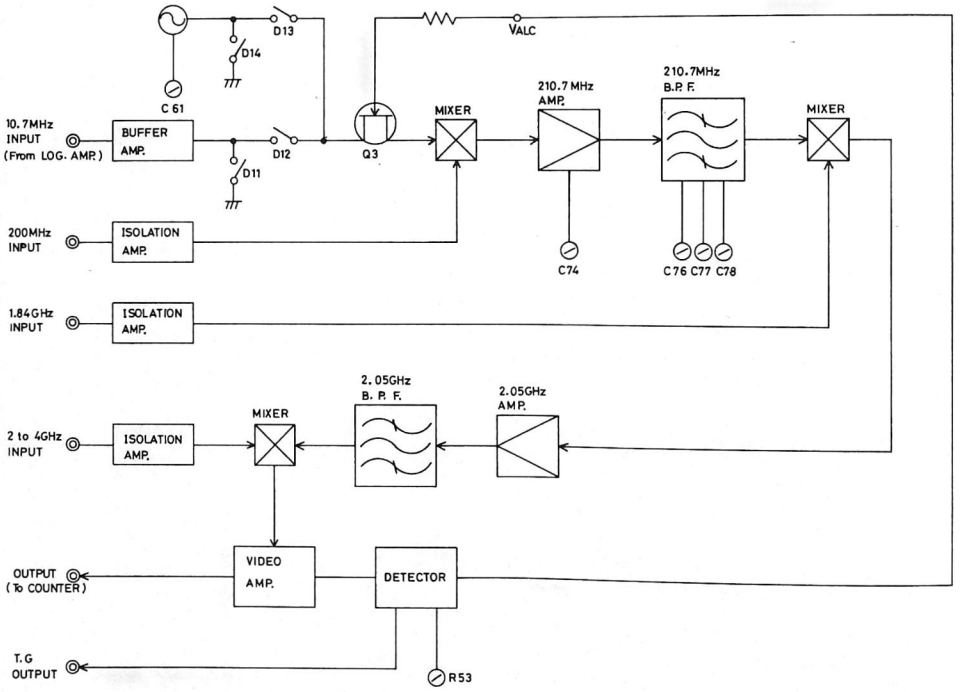


Fig. 5-20 TRACKING GENERATOR Section Block Diagram

5-3-13 FREQUENCY COUNTER Section (MEP-260)

The output signal of the tracking generator is the input signal to the spectrum analyzer.

By connecting the output signal to the frequency counter, the frequency of any arbitrary spectrum is known. The frequency counter functions regardless of the input signal level, enabling stable reading of the low level signal equivalent to the input sensitivity of the spectrum analyzer.

The signal output from tracking generator enters RF AMP. and the waveform is formed in the Schmitt circuit.

The signal is then divided into four equal parts by the high speed divider, the frequency is demultiplied into 1/2 (1/8 (188 MHz) for max. 1500 MHz), and enters the counter circuit. Then, the signal is further frequency demultiplied into 1/2 and 1/5 and counted in the counter (LSI).

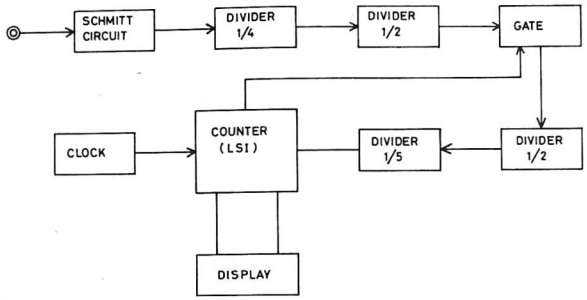


Fig. 5-21 FREQUENCY COUNTER Section Block Diagram

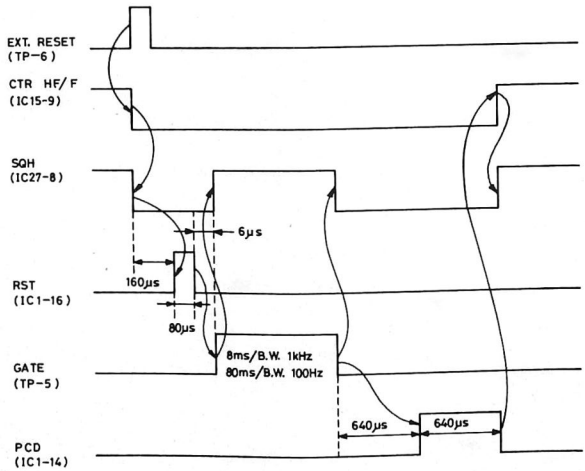


Fig. 5-22 Timing Chart of Counter Control Signal

CHAPTER 6
ACCESSORY (Standard and Optional)

-TR-1625	RF Coupler (DC to 1000MHz)
-TR-1626	RF Coupler (DC to 500MHz)
MEP-290 Series	High-pass Filter
-TR-1656	CRT Hood
-TR-1711	Log.-Periodic Antenna
-TR-1722	Halfwave Dipole Antenna
-TR-1821	Trolley
-TR-1927	Battery Pack
TC-07	Carrying Case
	Camera Mount Complete
	NP-BNCJ Conversion Adaptor
	UM-UM Linear Adaptor
	N-SMA Conversion Adaptor
	SMA-SMA Adaptor
MI-02	Input Cable
MI-04	Input Cable
MC-36	Connection Cable
MC-37	Connection Cable
MC-61	Connection Cable
MC-14	Connection Cable
MM-17	Connection Cable

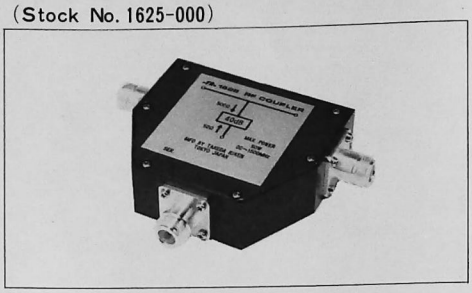
-TR-4122B

Index No.	Model No., Description	Stock No.	Quantity
1	Input Cable (BNC-BNC)	MI-02	2
2	Input Cable (N-N)	MI-04	2
3	Connection Cable (BNC-BNC)	MC-61	1
4	NP-BNCJ Conversion Adaptor	JUG201	2
5	Fuse 1A (Slow Blow) ※		2
6	Filter (Light blue)	MSP-0127-0133-6	1
7	CRT Hood **-TR-1656**	1656-000	1
8	Front Cover	MEG-0012-0165-3	1
9	Hexagonal Wrench 3mm/4mm		1 each
10	Maintenance Manual		1
11	Adjustment Board **CY-822**	CY822	1

※0.5A for AC200V, 220V or 240V specification.

-*TR*-1625 RF Coupler

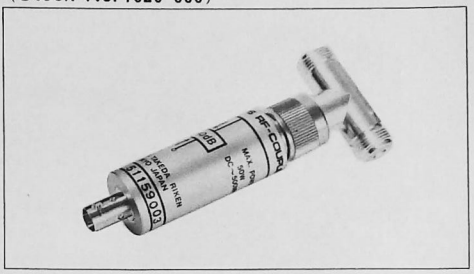
(Stock No. 1625-000)



Frequency range: DC to 1000MHz
Maximum input: 50W
Coupling factor: 40dB ± 1dB
Impedance : 50Ω/main & sub routes
V.S.W.R. : 1.5 or less
Insertion loss : 1dB or less
Connector : Main route/N type, sub routes/ BNC type

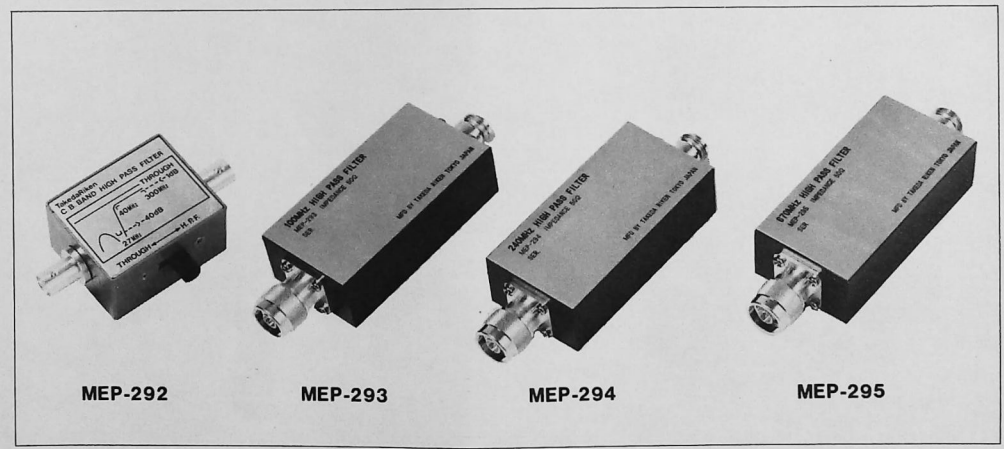
-*TR*-1626 RF Coupler

(Stock No. 1626-000)



Frequency range: DC to 500MHz
Maximum input: 50W
Coupling factor: 40dB ± 1dB
Impedance : 50Ω/main & sub routes
V.S.W.R. : 1.5 or less
Insertion loss : 1dB or less
Connector : Main route/N type, sub routes/ BNC type

MEP-290 Series High-pass Filter

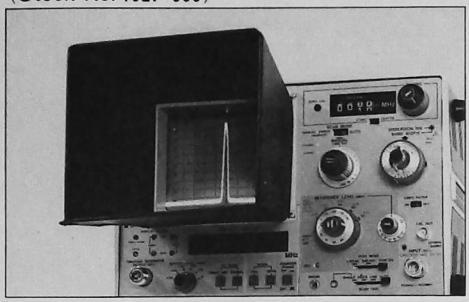


MEP-292 MEP-293 MEP-294 MEP-295

	MEP-292	MEP-293	MEP-294	MEP-295
Frequency Band	27MHz	60MHz	150MHz	400MHz
Frequency Range	26MHz to 30MHz	50MHz to 80MHz	120MHz to 190MHz	335MHz to 520MHz
Cut-off Frequency	40MHz	100MHz	240MHz	670MHz
Attenuation Characteristic	35dB or more/28MHz or less 40dB or more /27MHz	50dB or more at 70MHz 30dB or more at 80MHz	50dB or more at 170MHz 30dB or more at 190MHz	50dB or more at 470MHz 30dB or more at 520MHz
Pass Band	40MHz to 300MHz	100MHz to 1000MHz	240MHz to 1000MHz	670MHz to 1500MHz
Insertion Loss	1dB or less at Pass Band	2dB or less at Pass Band	2dB or less at Pass Band	2dB or less at Pass Band
Impedance	50Ω (BNCJ-BNCJ)	50Ω (NP-NJ)	50Ω (NP-NJ)	50Ω (NP-NJ)
Stock No.	MEP-292	MEP-293	MEP-294	MEP-295

-*TR*-1927 Battery Pack

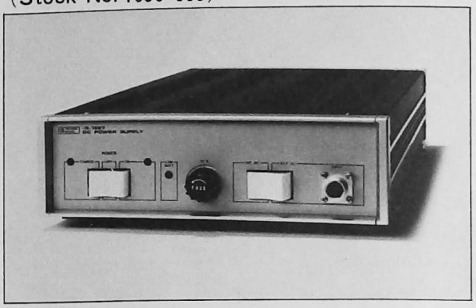
(Stock No. 1927-000)



It is designed to cover the CRT section of **-*TR*-4122B** Spectrum Analyzer for use outdoors or at bright environment. Open section 140 x 155mm and 160mm long. Made of chloridized vynil and can be folded.

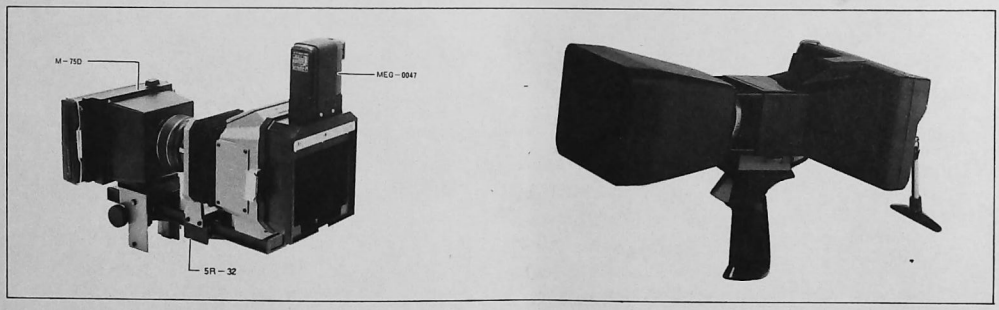
-*TR*-1656 CRT Hood

(Stock No. 1656-000)



Internal battery capacity : 10AH (12V) Ni-Cd
Continuous operating hour
:about 1.0 hours
Charging hour : about 15 hours
External battery : +10V to +15V
Discharging hour : AC100V±10%, 50/60Hz, about 35VA
Environment temperature
: 0°C to +35°C (in operation)
−30°C to +35°C (in long storage)
Dimensions : abt. 294(W) x 87(H) x 500(D) mm
Weight : about 12kg

Camera Mount Complete Set

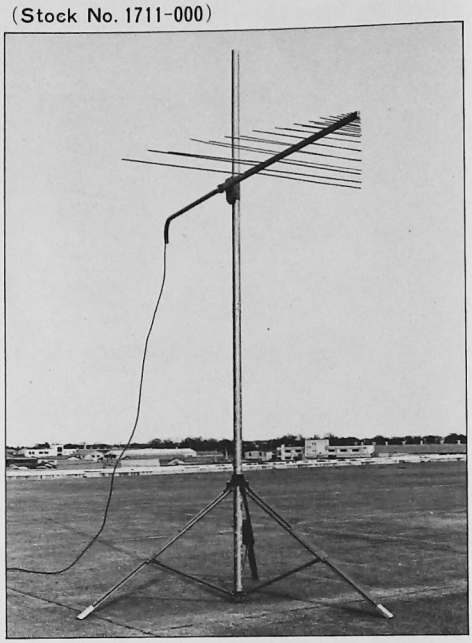


This set composed of Polaroid[note] camera **M-75D,** Camera mount set **5R-32,** and Bezel adapter with flash **MEG-0047** takes photoes of CRT screen.
A camera bag is available to carry all of the above.

To use Polaroid camera **M-085,** attached Hood **#85-24** to it. Scales on the CRT screen cannot be taken with these camera and hood.
Note) Registered trademark of the Polaroid Corporation.

-*TR*-1711 Log-Periodic Antenna

(Stock No. 1711-000)

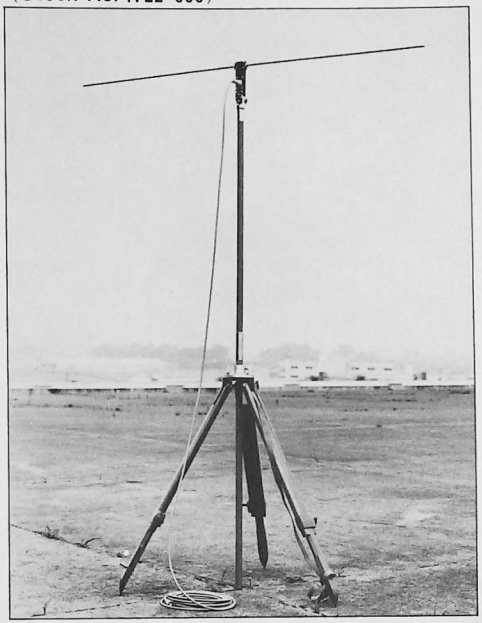


This is an antenna for wideband reception with the frequency range from 80 to 1000MHz.
Can be effectively used for radiowave surveillance and for analyzing interference waves generated in wide range.

Frequency range: 80MHz to 1000MHz
Gain : 5dB (λ/2 dipole antenna ratio)
Front/back ratio: 14dB or more
Input/output impedance: 50Ω
Weight : Antenna main only about 5kg
Composition : log-periodic antenna (31-element 2 pcs, antenna main & balancer), angle adjuster (45°–0°–90°), Supporting pole, tripod, measurement cable (10 meters with N type connector), element bag, antenna main bag.

-*TR*-1722 Halfwave Dipole Antenna

(Stock No. 1722-000)



This antenna is used with the element length specifically changed in accordance with the measuring frequency in field strength and interference wave measurements with Spectrum Analyzer.

Frequency range: 25MHz to 1000MHz
Element 1 : 25MHz to 80MHz
Element 2 : 80MHz to 250MHz
Element 3 : 250MHz to 600MHz
Element 4 : 600MHz to 1000MHz
Impedance : 50Ω
Polarized wave : Horizontal and vertical switchable
On ground antenna height : 1meter to 4 meters approx.
Tripod : Folding type
Accessory coaxial cable : 50D·2W, 10 meters with N type connector

-TR-1821 Trolley

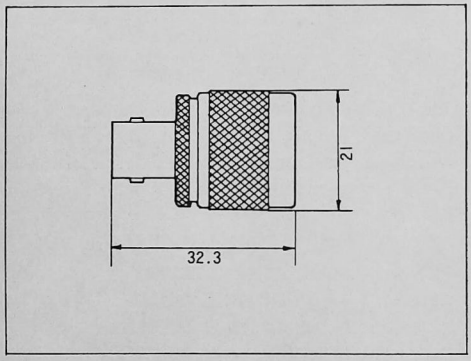
(Stock No. 1821-000)

TC-07 Carrying Case

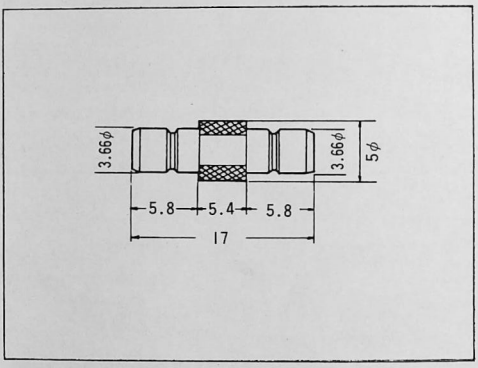
(Stock No. 9994-070)

NP-BNCJ Conversion Adaptor

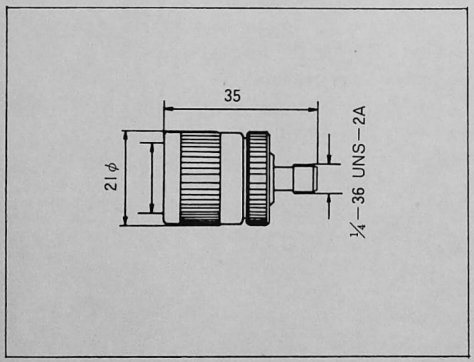
(Stock No. JUG201)



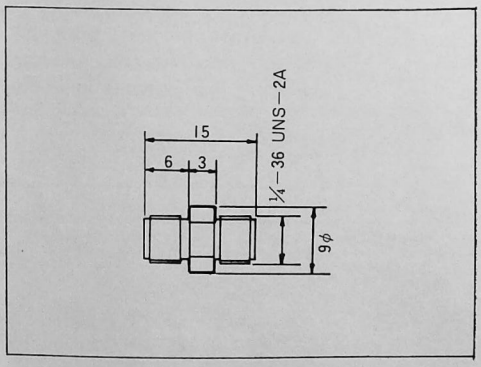
UM-UM Linear Adaptor



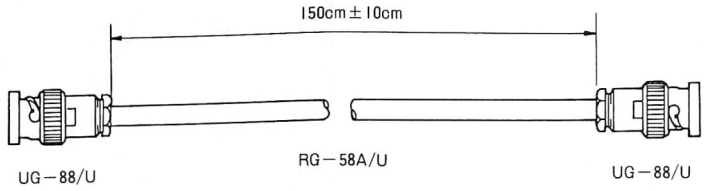
N-SMA Conversion Adaptor



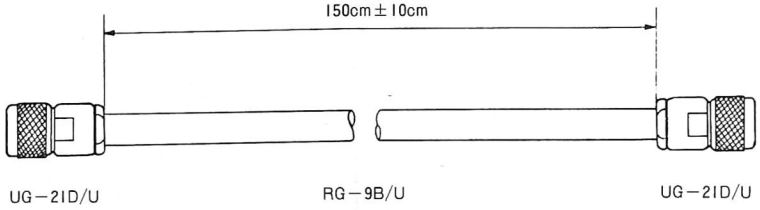
SMA-SMA Adaptor



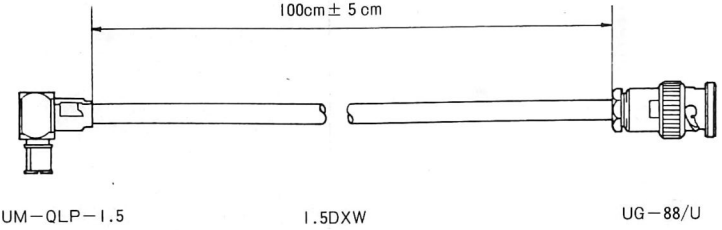
Article	Specifications	Stock No.
MI-02 Input Cable	BNC－BNC (50Ω)	MI－02



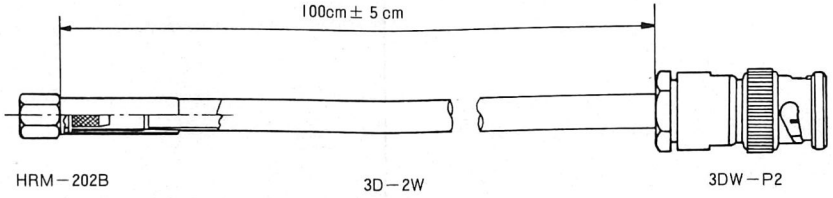
MI-04 Input Cable	N－N (50Ω)	MI－04



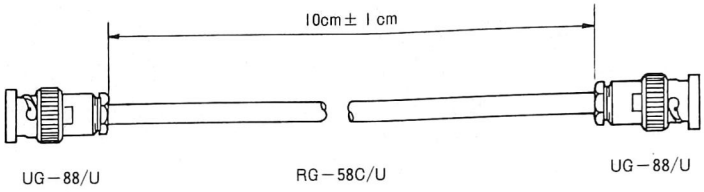
MC-36 Connection Cable	BNC－UM(50Ω)	MC－36



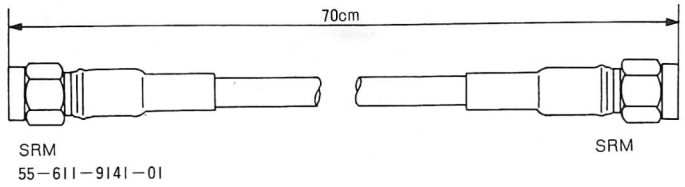
MC-37 Connection Cable	BNC－SMA(50Ω)	MC－37



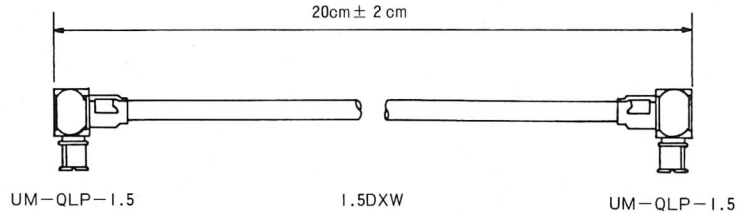
Article	Specifications	Stock No.
MC-61 Connection Cable	BNC－BNC (50Ω)	MC－61



MM-14 Connection Cable	SRM－SRM (50Ω)	MM－14



MM-17 Connection Cable	UM－UM (50Ω)	MM－17



CHAPTER 7
TROUBL SHOOTING

7-1 General

This chapter describes troubleshooting for the **-TR-4122B** spectrum analyzer using a flow chart. If a repair is performed to correct a malfunction, always carry out performance testing and calibration before starting operation again. Numbers and symbols used in the text are same as those printed and marked on the circuit diagram and board.

7-2 Preparation

The equipment and tools required and the general precautions for troubleshooting are described below. Use the equipment listed in [Table 7-1], or its equivalent.

Table 7 – 2 Tools and jigs for trouble-shooting

Item	Stock No.	Remarks
Input Cable	**MI-02**	BNC–BNC
Connection Cable	**MC-36**	BNC–UM
Connection Cable	**MC-37**	BNC–SMA
Connection Cable	**MC-61**	BNC–BNC
Connection Cable	**MM-14**	SMA–SMA
Connection Cable	**MM-17**	UM–UM
Conversion Adaptor	**JUG201**	JUG-201A/U
Linear Adaptor		UM–QA–JJ
Adaptor		HRM-501
Adjustment Board	**CY-822**	22 Pin Double
RF Block Dummy Cover		

Repair tool set
Philips screwdriver (3mm, 4mm), Standard screw driver (2mm), Hexagonal wrench (3mm, 4mm), Soldering iron, Tweezers, Plier, Nipper.

Table 7 – 1 Equipment for Trouble Shooting

Equipment	Specifications		Recommended equipment
(1) Signal generator	Frequency: Output level: Output impedance: Output level flatness: Frequency accuracy:	100 kHz to 1500 MHz +10 dBm to -30 dBm 50 Ω ±0.5 dB ±0.01%	
(2) Frequency counter	Frequency: Sensitivity: Stability:	400 kHz to 1000 MHz 10 mVrms 5×10^{-8}/day	Takeda Riken **-TR-5123G**
(3) High frequency power meter	Frequency: Sensitivity: Accuracy:	100 kHz to 1500 MHz -30 dBm to +20 dBm ±0.5 dB	HP-436A
(4) Attenuator	Frequency: Attenuation: Accuracy:	DC to 500 MHz 10 dB step 0 to 100 dB 1 dB step 0 to 10 dB ±0.5 dB	
(5) Low distortion oscillator	Frequency: Harmonic distortion: Output level:	5 MHz to 750 MHz -80 dB or less -10 dBm (50 Ω)	
(6) Spectrum analyzer	Frequency range: Sensitivity: Resolution:	100 kHz to 2000 MHz -120 dBm 30 Hz to 300 kHz	Takeda Riken **-TR-4110/4111**
(7) Digital multimeter	Measuring range: Accuracy: Input impedance:	0 V to ±1000 V ±0.1% 10 MΩ or more	Takeda Riken **-TR-6855**
(8) DC high-voltage probe	Measuring range:	+5 kV to -2 kV	Takeda Riken **-TR-1116**

7-2-1 General precautions

1. This troubleshooting guide is written for skilled repair personnel already experienced in this type of instrument, and electronics engineers.
2. The line voltage should be within 100 V (120 V, 200 V, 220 V, 240 V) ±10% and the line frequency either 50 Hz or 60 Hz.
3. The power cable has a three-pin plug; the round center pin of this plug is the ground pin. If the AC line is connected to the mains supply through a two pin adaptor, connect the pigtail of the connector or the ground terminal **GND** on the rear panel of instrument to an earth ground. [Fig. 2-1]
4. Always perform troubleshooting in a place free from dust, vibration, noise.
5. Before checking the inside of the instrument, always set the **POWER** switch to **OFF**. Set this switch to **OFF** also for the removal and insertion of circuit boards.
6. When making measurements with an oscilloscope or digital multimeter, always take care to avoid shortcircuitting adjacent terminals or lead wires.
7. For the replacement of defective parts on the board, use a 20 to 30 W soldering iron. Soldering should be completed within the shortest time. If a soldering iron is left in contact with parts (semiconductors in particular) for a long time, damage may occur. To remove parts with many terminals (such as ICs), the use of a solder absorber is recommended.
8. When replacing parts, always use parts listed in the attached parts list or their equivalent. For electrical or mechanical parts marked with an asteristix in the list, contact TAKEDA RIKEN or your nearest branch or agent.
9. High voltage is used in this instrument. In troubleshooting of the high-tension block, take care to avoid electrical shock. Always allow more than five minutes after turning **OFF** the power, before proceeding with parts replacement.

7-3 Disassembly/Reassembly of Boards and Unit

Disassemble and reassemble the board and unit correctly in accordance with the assembly drawing in Chapter 8, "Parts List" and the photos in this section. Disconnection of connection cables is not described here. The blocks listed below are replaced completely as units. To replace units, contact TAKEDA RIKEN or your nearest branch or agent.

7-3-1 Disassembly/Reassembly of the SE160 Regulator Board

1. Remove the four set screws ① on board SE160, as shown in [Fig. 7-2].

7-3-2 Disassembly/Reassembly of the PG177 YIG DRIVER

1. Remove the set screw ① shown in [Fig. 7-1], and pull out the board.
2. If necessary, mount the board via the adjustment board **CY-822**.

7-3-3 Disassembly/Reassembly of the SG178 CRT DRIVER

1. Pull out board SG178 as shown in [Fig. 7-2], and mount the board via **CY-822** if necessary.

7-3-4 Disassembly/Reassembly of the PF119 Ramp Generator

1. Pull out board PF119 as shown in Fig. 7-2, and mount the board via **CY-822** if necessary.

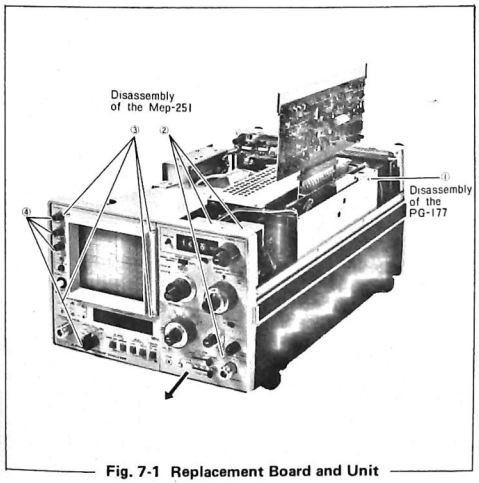


Fig. 7-1 Replacement Board and Unit

7-3-5 Disassembly/Reassembly of the PH190 LOG. AMP.

1. Remove the four set screws ② of the IF shield cover shown in [Fig. 7-2], and take off the cover.
2. Pull out board PH190, and mount the board via **CY-822** if necessary.

7-3-6 Disassembly/Reassembly of the PK026 IF-II

1. Remove the four set screws ② of the IF shield cover shown in [Fig. 7-2], and take off the cover.
2. Pull out the board PK026, and mount the board via **CY-822** if necessary.

7-3-7 Disassembly/Reassembly of the PK022 IF-I

1. Remove the four set screws ② of the IF shield cover shown in [Fig. 7-2], and take off the cover.
2. Pull out the board PK022, and mount the board via **CY-822** if necessary.

7-3-8 Disassembly/Reassembly of the MEP-255 RF block

1. Refer to the assembly drawing [Fig. 8-15] and take off the top cover.
2. To disassemble the RF block, remove the five set screws ① of MEP-255 and MEP-257 shown in [Fig. 7-4].

7-3-9 Disassembly/Reassembly of the MEP-257 Tracking Generator

1. Refer to the assembly drawing [Fig. 8-14] and take off the T.G. shield case cover.
2. To disassemble the tracking generator, remove the five set screws ① of MEP-255 and MEP-257 shown in [Fig. 7-4].

7-3-10 Disassembly/Reassembly of the MEP-260 Frequency Counter

1. Refer to the assembly drawing [Fig. 8-13] and take off the RF amplifier cover (board SH212) and top cover.
2. To disassemble the frequency counter, first remove MEP-255 and MEP-257. Remove the four set screws ① of MEP-260 shown in [Fig. 7-3].

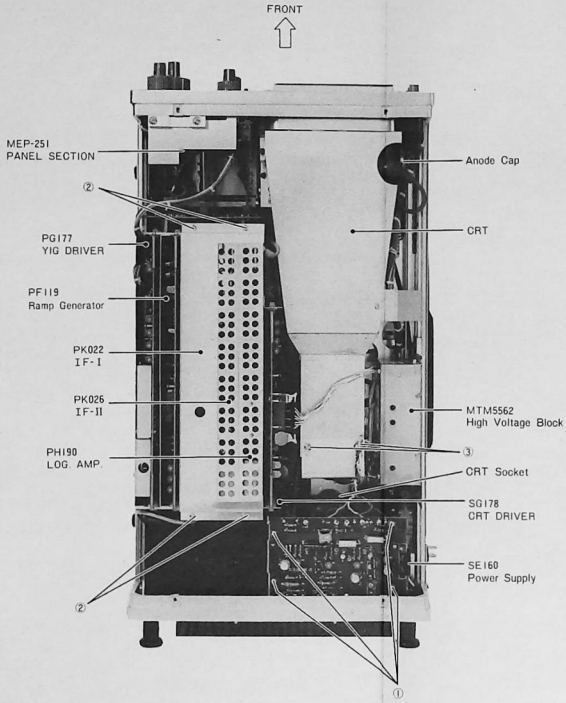


Fig. 7-2 Top View

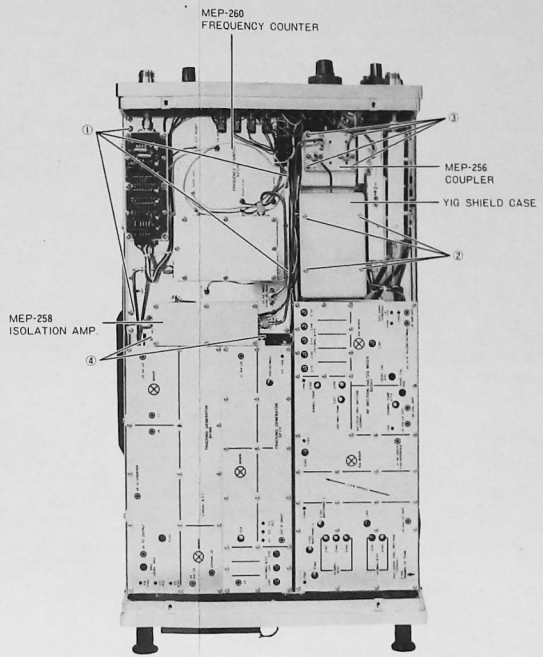


Fig. 7-3 Bottom View

Fig. 7-2/3 Replacement Board and Unit

7-3-11 Disassembly/Reassembly of the SG204 YIG Power Supply and Filter

1. Remove the four set screws (2) of the YIG shield case cover, and take off the cover.
2. Pull out board SG204 from inside the YIG shield case.

7-3-12 Disassembly/Reassembly of the MEP-251 Panel Section

1. Remove the three set screws (2) of MEP-251 shown in [Fig. 7-1].
2. Remove the four set screws (3) of the CRT hood, and take off the hood.
3. Pull out MEP-251 in the direction of the arrow.

7-3-13 Disassembly/Reassembly of the MEP-253 1st Mixer

1. Remove the two set screws (3) of MEP-253 shown in [Fig. 7-4].

7-3-14 Disassembly/Reassembly of the MEP-254 interface

1. To disassemble the MEP-254, first remove MEP-255 and MEP-257.
2. Remove the four set screws (1) of MEP-254 shown in [Fig. 7-6].

7-3-15 Disassembly/Reassembly of the MEP-256 Coupler

1. Remove the four set screws (3) of MEP-256 shown in [Fig. 7-3].

7-3-16 Disassembly/Reassembly of the MEP-258 Isolation Amplifier

1. To disassemble the MEP-258, first remove MEP-255 and MEP-257.
2. Remove the two set screws (4) of MEP-258 shown in [Fig. 7-3].

7-3-17 Disassembly/Reassembly of the MEP-259 Isolation Filter

1. To disassemble the MEP-259, first remove MEP-255 and MEP-257.
2. Remove the two set screws of MEP-259 mounted on the bottom cover (1) of MEP-257. Refer to [Fig. 7-6].

7-3-18 Disassembly/Reassembly of the MTM5562 High Voltage Block

Remove the four set screws (2) of MTM5562 shown in [Fig. 7-3].

7-3-19 Replacing the CRT

1. Remove the CRT socket and anode cap.
2. Remove the two screws (3) of the CRT stopper, shown in [Fig. 7-2].
3. Remove the four set screws (3) of the CRT hood, shown in [Fig. 7-1] and the controls (4) respectively for **INTENSITY, FOCUS, BASELINE CLIPPER,** and **T.G. OUTPUT LEVEL.**
4. Take off the panel and pull out the CRT forward.

7-3-20 Replacing the YIG tuned Oscillator

1. Remove the four set screws (2) of the YIG shield cover shown in [Fig. 7-3], and take off the cover.
2. Remove the four set screws (1) of the YIG base C shown in [Fig. 7-5].
   Refer to the assembly drawing in [Fig. 8-10].

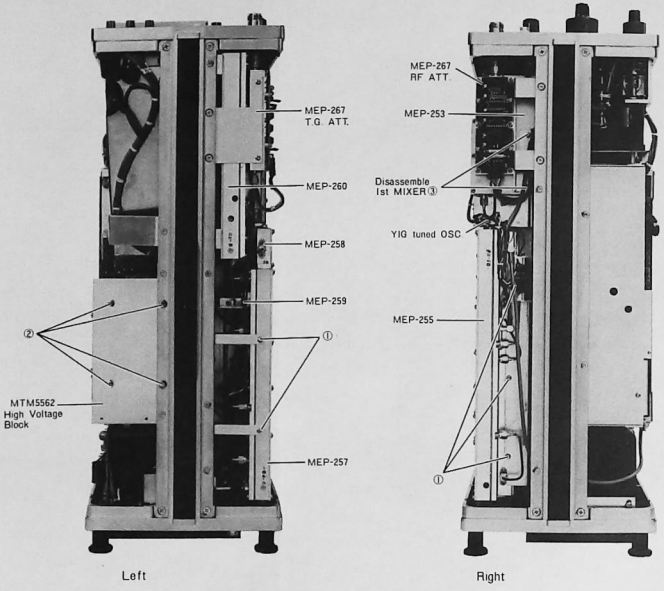


Fig. 7-4 Side View

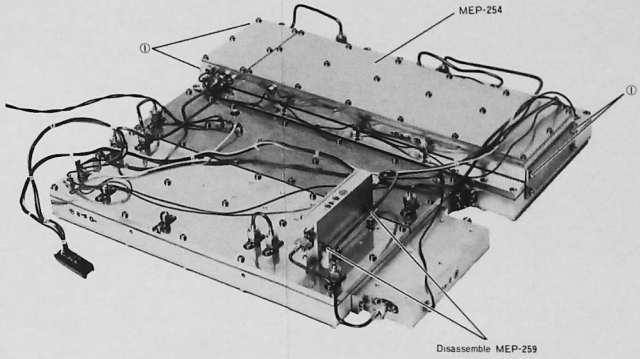


Fig. 7-6 Replacement MEP-254/259

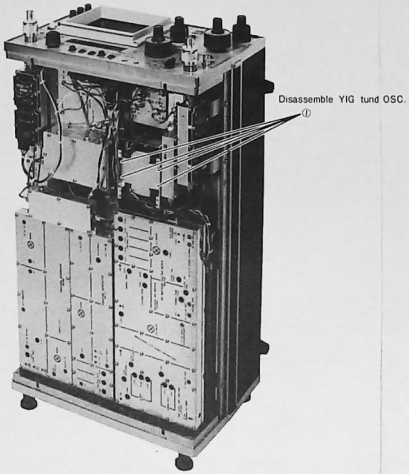


Fig. 7-5 Replacement YIG Tuned OSC.

Fig. 7-4/5/6

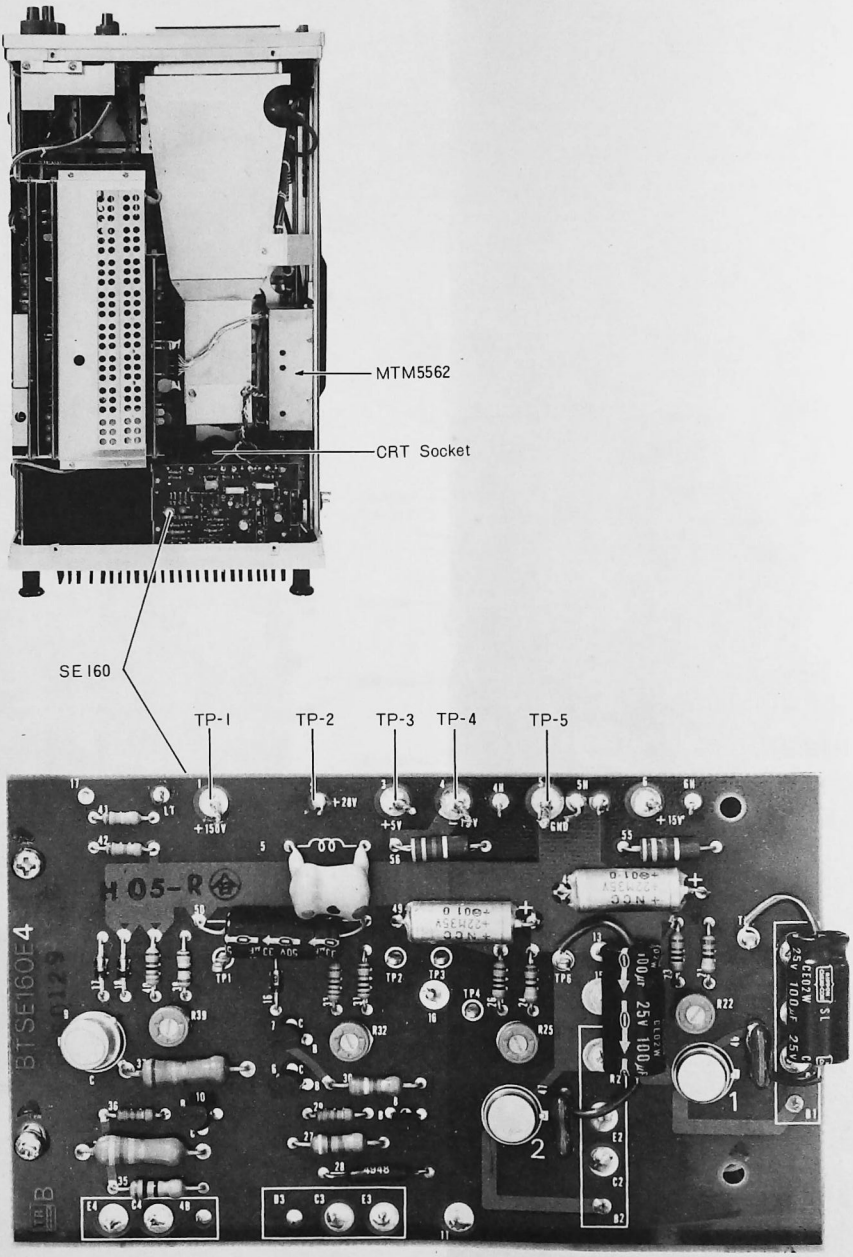
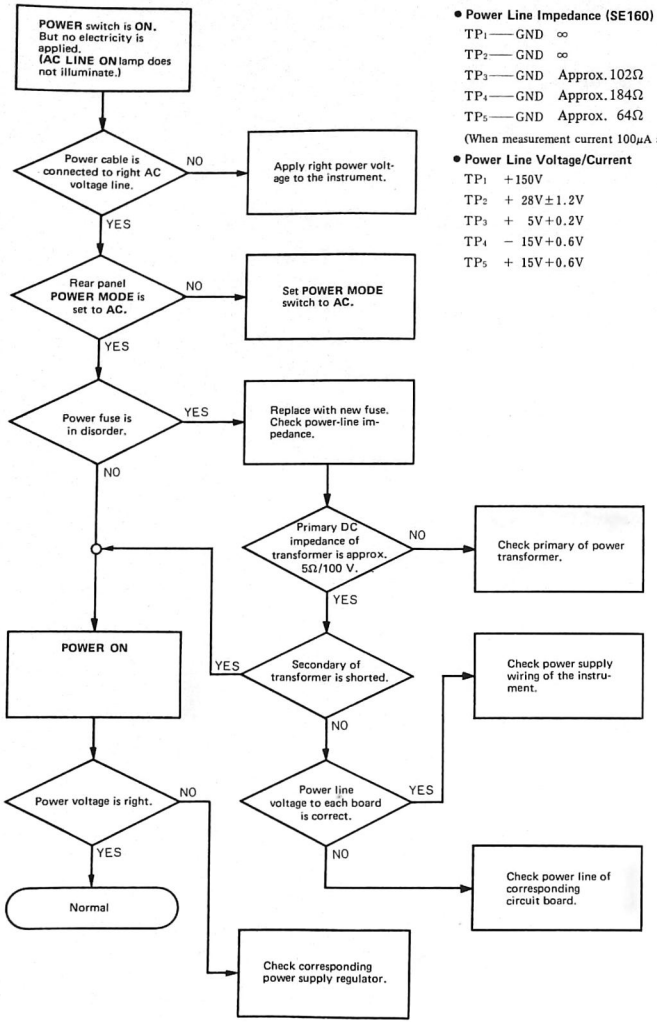


Fig. 7-7 POWER SUPPLY Section (SE160) Check Point

CHART—1



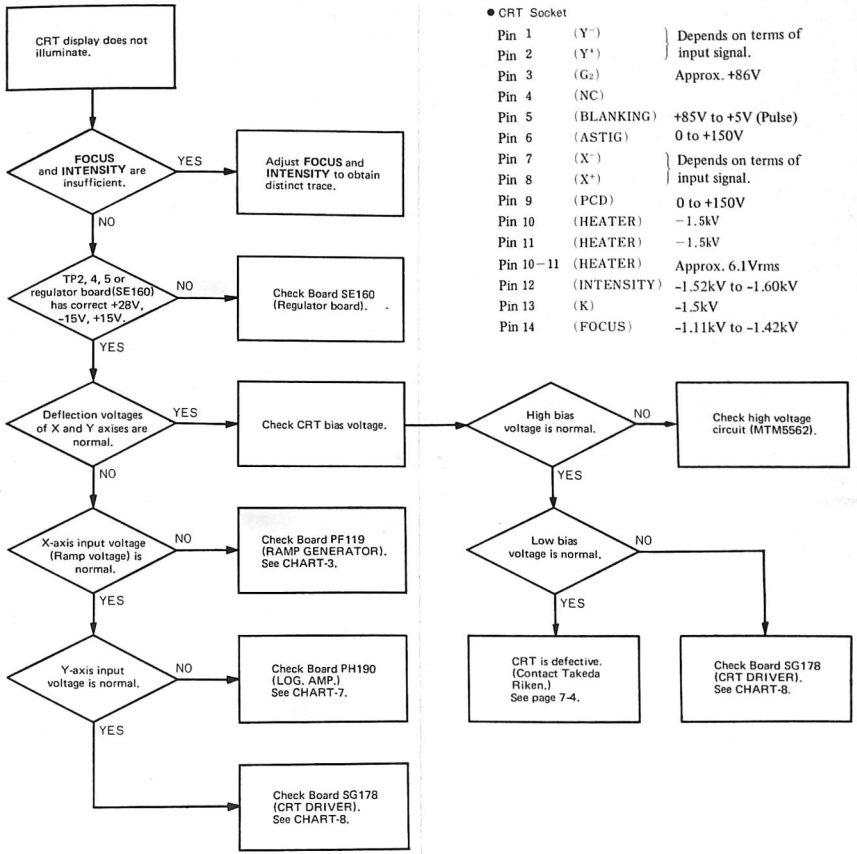
- **Power Line Impedance (SE160)**

TP_1	GND	∞
TP_2	GND	∞
TP_3	GND	Approx. 102Ω
TP_4	GND	Approx. 184Ω
TP_5	GND	Approx. 64Ω

(When measurement current 100μA at OHM range is used.)

- **Power Line Voltage/Current**

TP_1	+150V
TP_2	+ 28V±1.2V
TP_3	+ 5V+0.2V
TP_4	− 15V+0.6V
TP_5	+ 15V+0.6V


CRT display does not illuminate.
FOCUS and INTENSITY are insufficient.
YES
Adjust FOCUS and INTENSITY to obtain distinct trace.
NO
TP2, 4, 5 or regulator board(SE160) has correct +28V, -15V, +15V.
NO
Check Board SE160 (Regulator board).
YES
Deflection voltages of X and Y axises are normal.
YES
Check CRT bias voltage.
NO
X-axis input voltage (Ramp voltage) is normal.
NO
Check Board PF119 (RAMP GENERATOR). See CHART-3.
YES
Y-axis input voltage is normal.
NO
Check Board PH190 (LOG. AMP.) See CHART-7.
YES
Check Board SG178 (CRT DRIVER). See CHART-8.
High bias voltage is normal.
NO
Check high voltage circuit (MTM5562).
YES
Low bias voltage is normal.
NO
YES
CRT is defective. (Contact Takeda Riken.) See page 7-4.
Check Board SG178 (CRT DRIVER). See CHART-8.

- **CRT Socket**

Pin 1	(Y^-)	Depends on terms of input signal.
Pin 2	(Y^+)	
Pin 3	(G_2)	Approx. +86V
Pin 4	(NC)	
Pin 5	(BLANKING)	+85V to +5V (Pulse)
Pin 6	(ASTIG)	0 to +150V
Pin 7	(X^-)	Depends on terms of input signal.
Pin 8	(X^+)	
Pin 9	(PCD)	0 to +150V
Pin 10	(HEATER)	−1.5kV
Pin 11	(HEATER)	−1.5kV
Pin 10−11	(HEATER)	Approx. 6.1Vrms
Pin 12	(INTENSITY)	-1.52kV to -1.60kV
Pin 13	(K)	-1.5kV
Pin 14	(FOCUS)	-1.11kV to -1.42kV

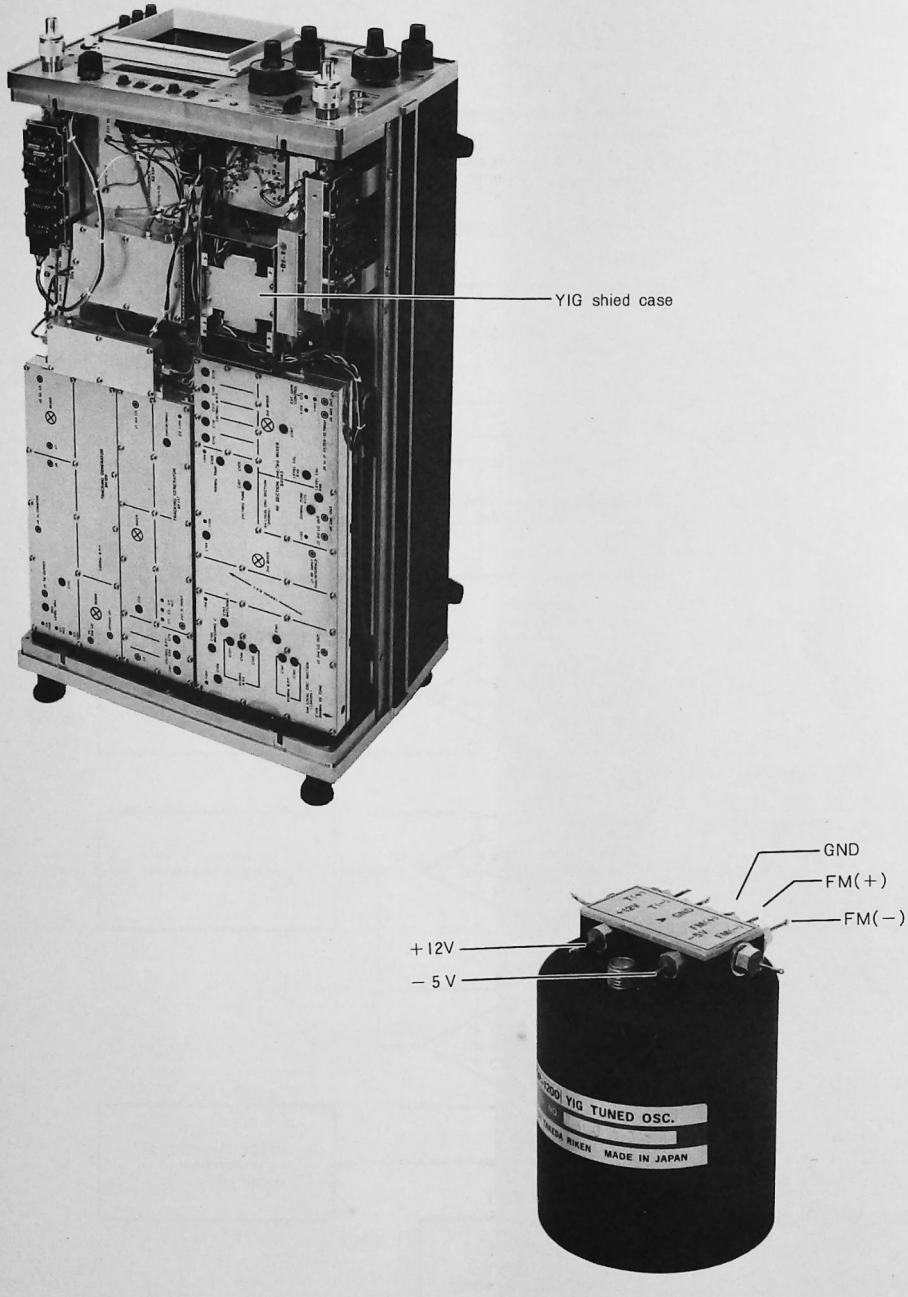


Fig. 7-8 YIG Tuned OSC. Check Point

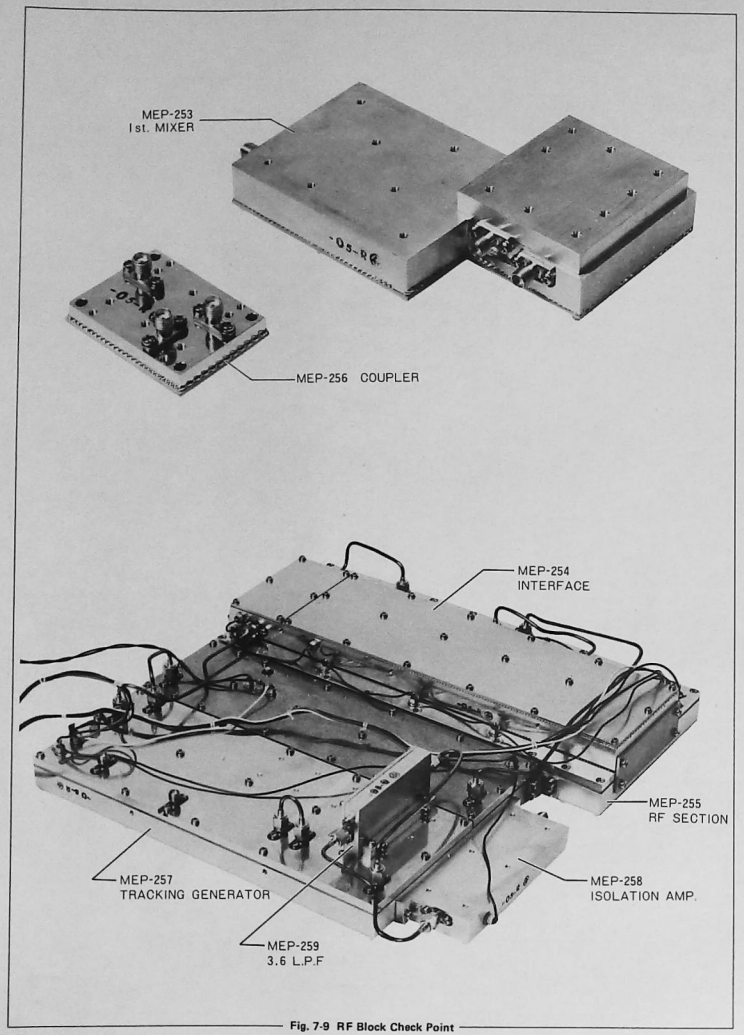
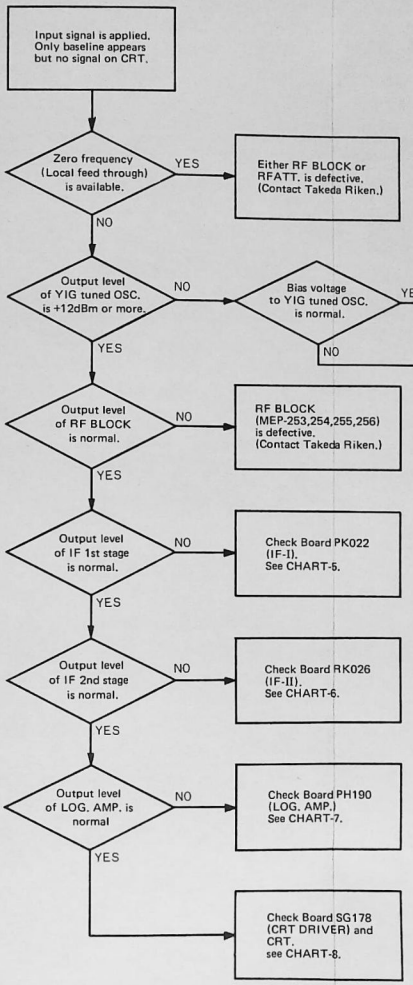


Fig. 7-9 RF Block Check Point

CHART－2


Input signal is applied. Only baseline appears but no signal on CRT.
Zero frequency (Local feed through) is available.
YES
Either RF BLOCK or RFATT. is defective. (Contact Takeda Riken.)
NO
Output level of YIG tuned OSC. is +12dBm or more.
NO
Bias voltage to YIG tuned OSC. is normal.
YES
YIG tuned OSC. is defective. (Contact Takeda Riken.)
NO
YES
Output level of RF BLOCK is normal.
NO
RF BLOCK (MEP-253,254,255,256) is defective. (Contact Takeda Riken.)
Check Board PG177 (YIG DRIVER). See CHART-4.
YES
Output level of IF 1st stage is normal.
NO
Check Board PK022 (IF-I). See CHART-5.
YES
Output level of IF 2nd stage is normal.
NO
Check Board RK026 (IF-II). See CHART-6.
YES
Output level of LOG. AMP. is normal
NO
Check Board PH190 (LOG. AMP.) See CHART-7.
YES
Check Board SG178 (CRT DRIVER) and CRT. see CHART-8.

- Zero frequency level is in 0dBm to −10dBm when **INPUT ATT.** is set to **0dB.**
- **Bias voltage of YIG Tuned OSC.**

  +12V ····· +12V ± 0.5V
  − 5V ····· − 5V ± 0.2V
  H ····· +15V ± 0.6V
  Main⁻ ····· PG177, TP10 (See CHART-4)
  FM⁺ ····· PG177, TP12 (See CHART-4)
  FM⁻ ····· 0V

- **Output level of RF BLOCK**

  At the following settings:
  CENTER FREQUENCY ····· **200MHz**
  INPUT ATT. ····· **0dB**
  Connect **CAL. OUT.** to **INPUT**
  Adjust **TUNING-FINE** for maximum level.
  Output level of RF BLOCK ····· 29dBm ± 1dBm

- **Output level of IF BLOCK**

  At the following settings:
  BAND WIDTH ····· **3MHz**
  REFERENCE LEVEL ····· **0dB**

  Output level of IF-I ····· −29dBm
  Output level of IF-II ····· −22dBm

- **Output of LOG. AMP.** ····· +3.5V

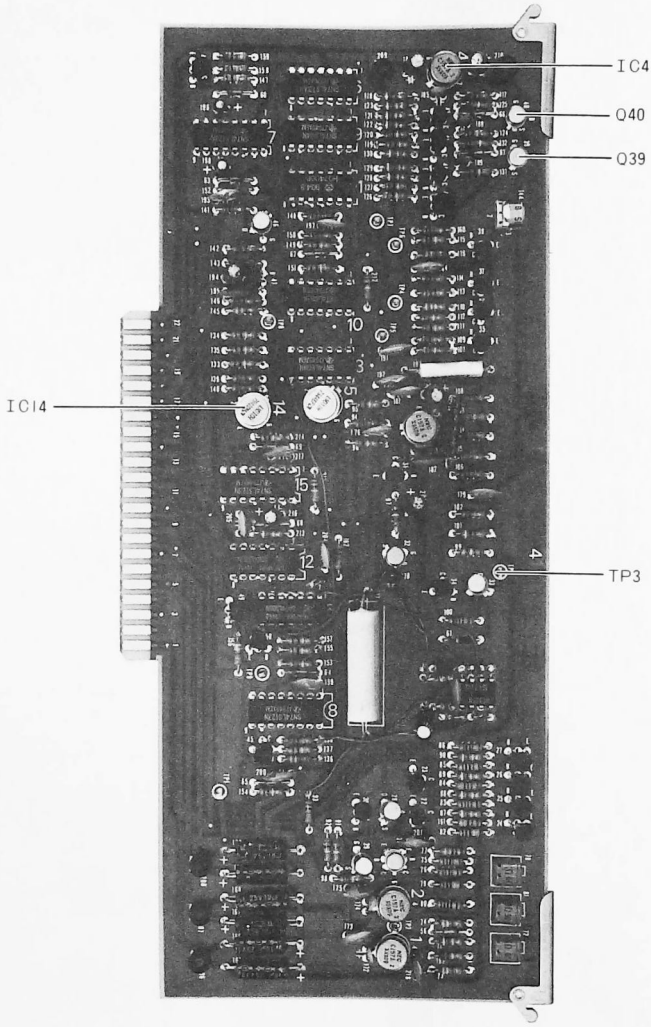
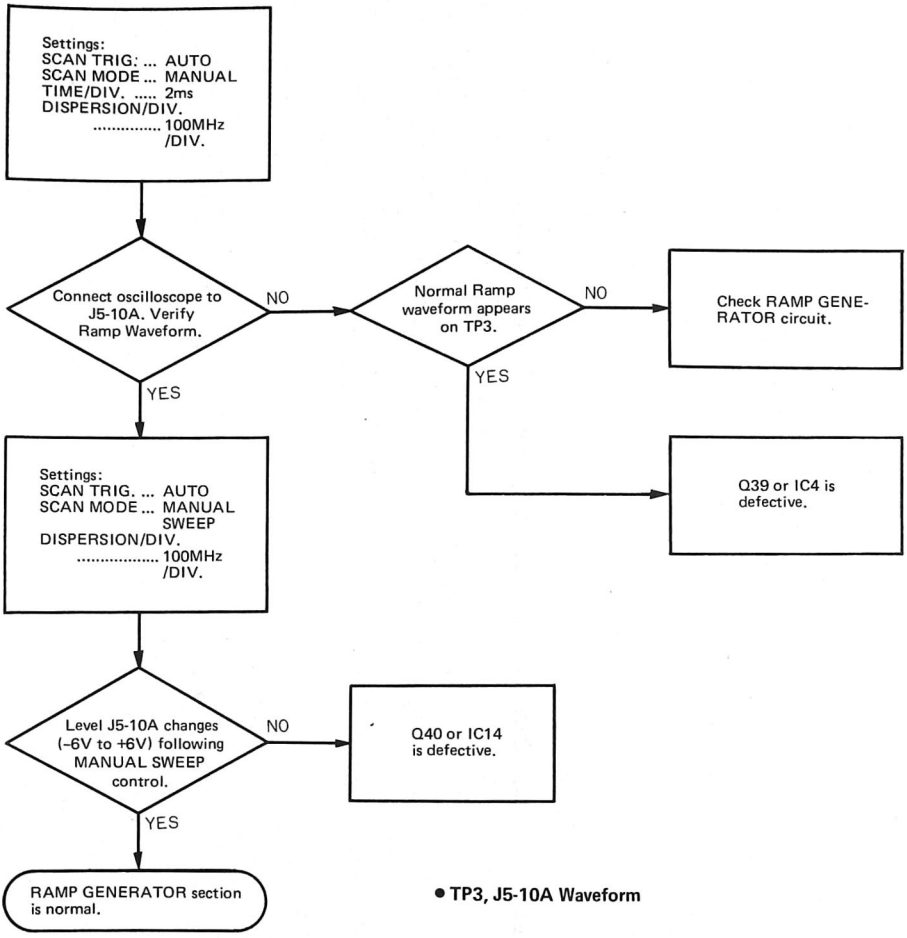
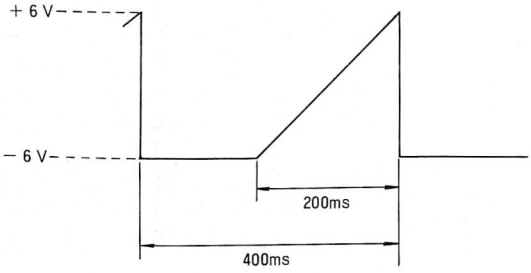


Fig. 7-10 PF119 (RAMP GENERATOR) Check Point

CHART — 3 RAMP GENERATOR (BOARD PF119)



• TP3, J5-10A Waveform



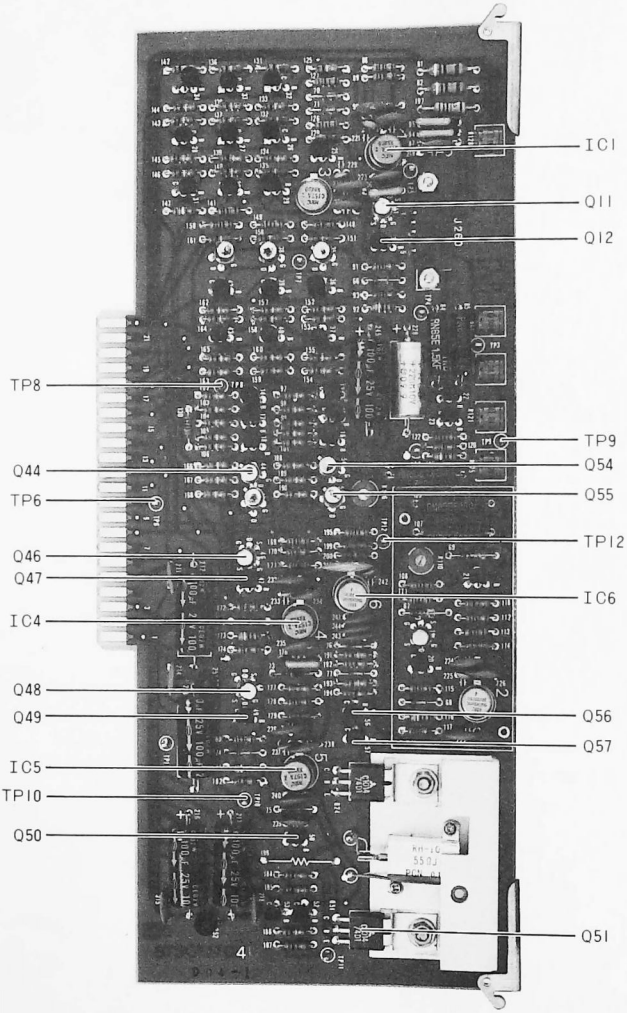


Fig. 7-11 PG177 (YIG DRIVER) Check Point

CHART—4 YIG DRIVER (BOARD PG177)

Settings:
SCAN TRIG.·····AUTO
SCAN MODE ·····MANUAL
TIME/DIV. ·····2ms
DISPERSION/DIV.·····100MHz /DIV.

Ramp waveform appears on TP6.
NO → Check RAMP GENERATOR circuit (Board PF119). See CHART-3.
YES

Waveform of TP8 is normal.
NO → Check attenuator of **DISPERSION/DIV.**
YES

Waveform of TP9 is normal.
NO → Check circuits IC4, Q44, Q46, Q47.
YES

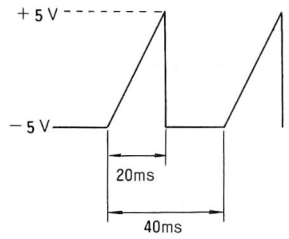
Waveform TP10 is normal.
NO → Check circuits IC1, Q11, Q12, IC5, and Q48 to Q51.
YES

Settings:
SCAN TRIG.·····AUTO
SCAN MODE ·····MANUAL
TIME/DIV. ·····2ms
DISPERSION/DIV.·····1MHz/DIV.

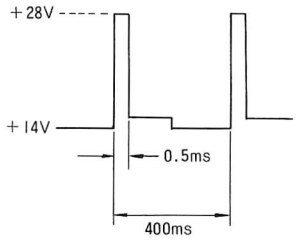
Waveform of TP12 is normal.
NO → Check circuits IC6, Q54 to Q57.
YES

YIG DRIVER section is normal.

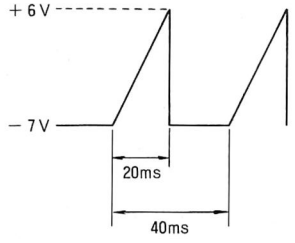
• TP6, TP8, TP9 Waveform



• TP10 Waveform



• TP12 Waveform



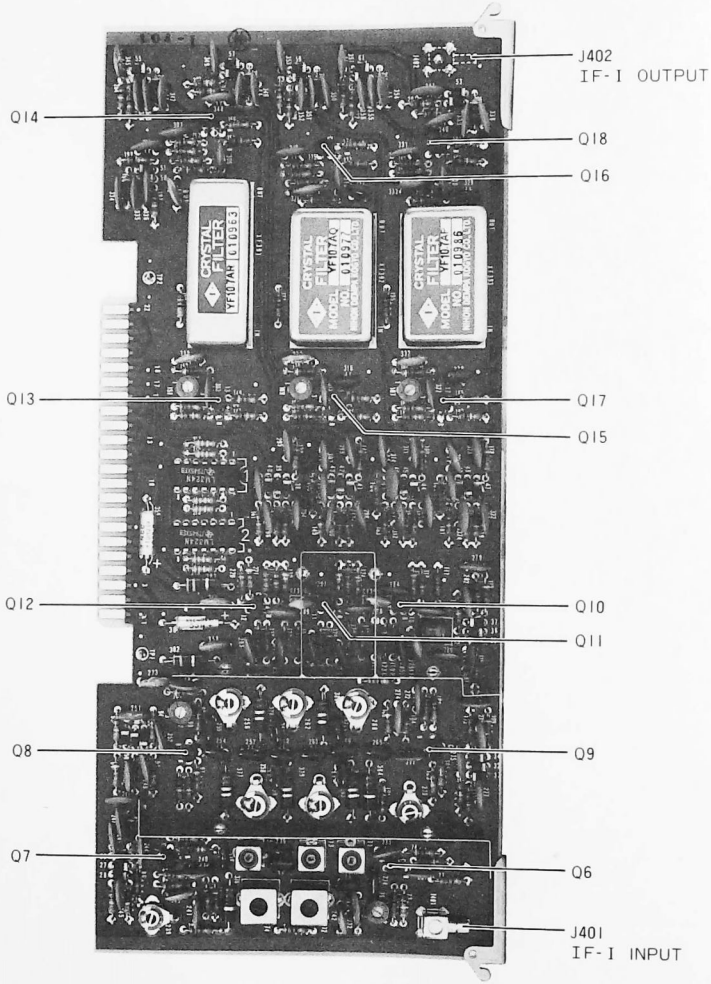
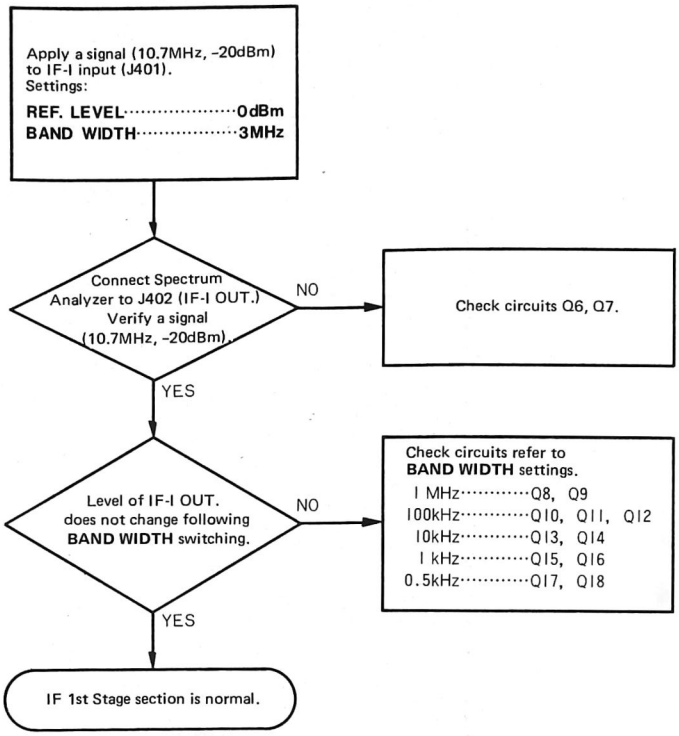


Fig. 7-12 PK022 (IF-I) Check Point

CHART — 5 IF-I (BOARD PK022)



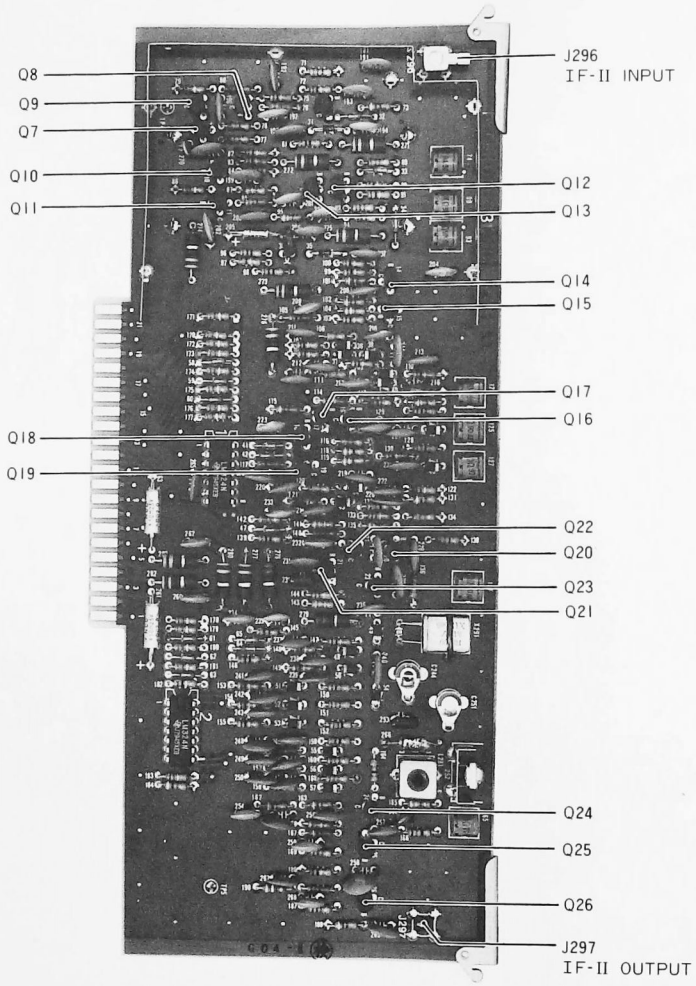
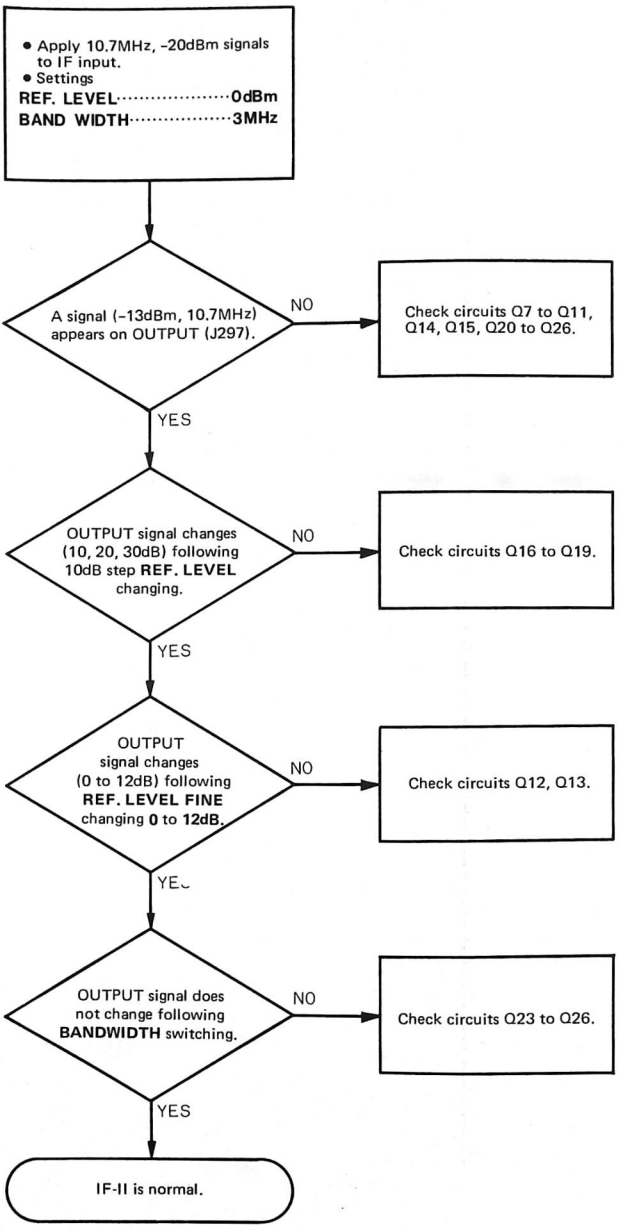


Fig. 7-13 PK026 (IF-II) Check Point

CHART — 6 IF-II (BOARD PK026)


• Apply 10.7MHz, -20dBm signals to IF input.
• Settings
REF. LEVEL·····0dBm
BAND WIDTH·····3MHz
A signal (-13dBm, 10.7MHz) appears on OUTPUT (J297).
NO
Check circuits Q7 to Q11, Q14, Q15, Q20 to Q26.
YES
OUTPUT signal changes (10, 20, 30dB) following 10dB step REF. LEVEL changing.
NO
Check circuits Q16 to Q19.
YES
OUTPUT signal changes (0 to 12dB) following REF. LEVEL FINE changing 0 to 12dB.
NO
Check circuits Q12, Q13.
YES
OUTPUT signal does not change following BANDWIDTH switching.
NO
Check circuits Q23 to Q26.
YES
IF-II is normal.

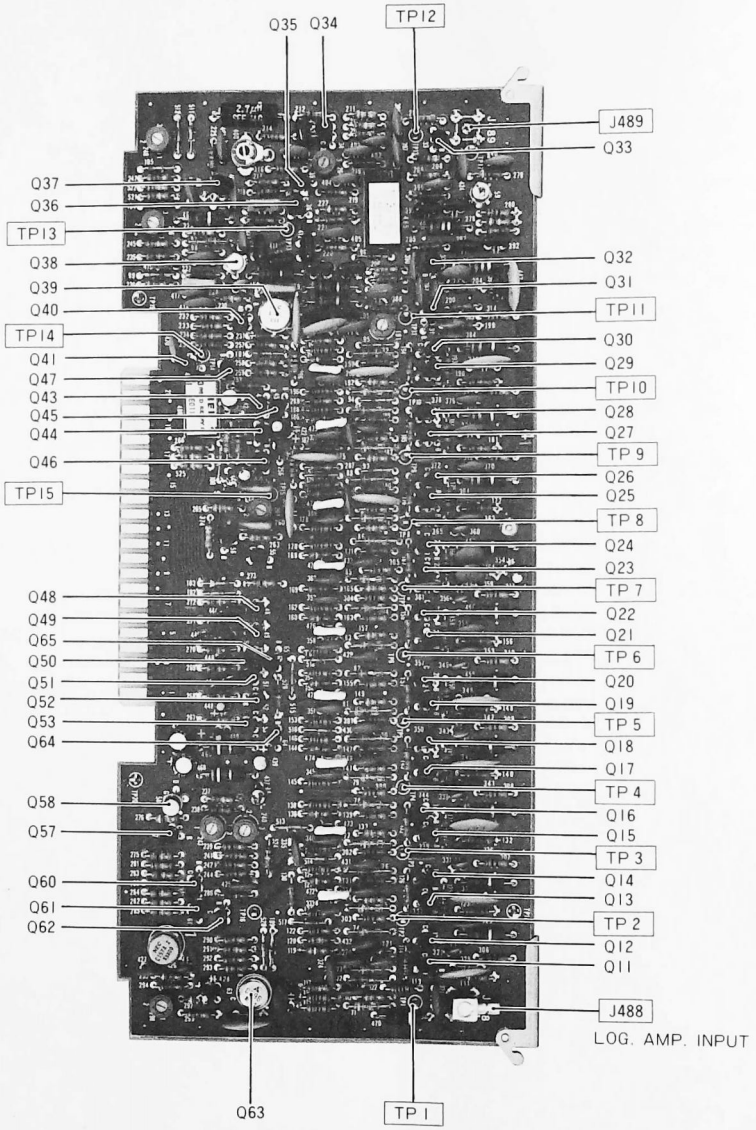
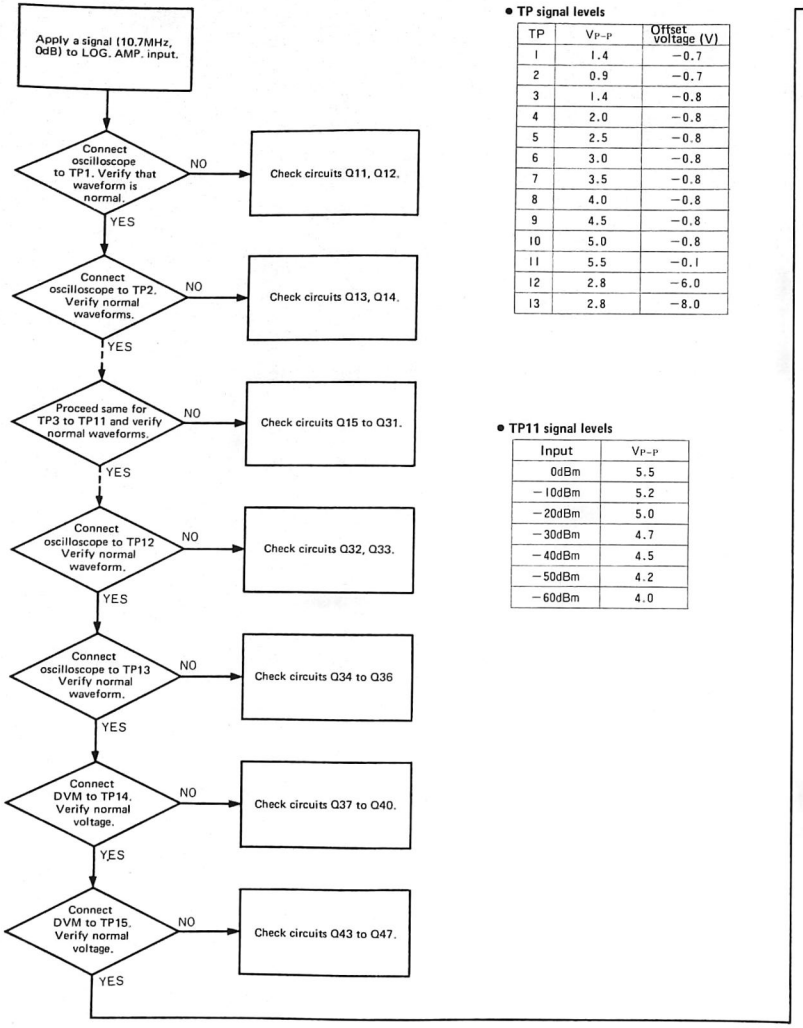


Fig. 7-14 PH190 (LOG. AMP.) Check Point

CHART — 7 LOG. AMP. (BOARD PH190)


Apply a signal (10.7MHz, 0dB) to LOG. AMP. input.
Connect oscilloscope to TP1. Verify that waveform is normal.
NO
Check circuits Q11, Q12.
YES
Connect oscilloscope to TP2. Verify normal waveforms.
NO
Check circuits Q13, Q14.
YES
Proceed same for TP3 to TP11 and verify normal waveforms.
NO
Check circuits Q15 to Q31.
YES
Connect oscilloscope to TP12. Verify normal waveform.
NO
Check circuits Q32, Q33.
YES
Connect oscilloscope to TP13. Verify normal waveform.
NO
Check circuits Q34 to Q36
YES
Connect DVM to TP14. Verify normal voltage.
NO
Check circuits Q37 to Q40.
YES
Connect DVM to TP15. Verify normal voltage.
NO
Check circuits Q43 to Q47.
YES
Set REF. LEVEL to -40dB. Verify +5.5V appears on TP15 (at input signal 0dB).
NO
Check circuits Q41, Q57, Q58.
YES
Voltage at TP15 does not change by switching BAND WIDTH.
NO
Check circuits Q48 to Q53.
YES
Settings
VERT. MODE ····· LINEAR
REF. LEVEL ····· 0dBm
BAND WIDTH ····· 1MHz
When input signal (10.7MHz, -7dBm) is applied, +5V appears on TP15.
NO
Check circuits Q60 to Q65.
YES
LOG. AMP. is normal.

● **TP signal levels**

TP	V_{P-P}	Offset voltage (V)
1	1.4	−0.7
2	0.9	−0.7
3	1.4	−0.8
4	2.0	−0.8
5	2.5	−0.8
6	3.0	−0.8
7	3.5	−0.8
8	4.0	−0.8
9	4.5	−0.8
10	5.0	−0.8
11	5.5	−0.1
12	2.8	−6.0
13	2.8	−8.0

● **TP11 signal levels**

Input	V_{P-P}
0dBm	5.5
−10dBm	5.2
−20dBm	5.0
−30dBm	4.7
−40dBm	4.5
−50dBm	4.2
−60dBm	4.0

● **TP14, TP15 signal level**

Input signal level	TP14	TP15
0dBm	+0.55V	+5.0V
−10dBm	+0.50V	+4.5V
−20dBm	+0.45V	+4.0V
−30dBm	+0.40V	+3.5V
−40dBm	+0.35V	+3.0V
−50dBm	+0.30V	+2.5V
−60dBm	+0.25V	+2.0V
−70dBm	+0.20V	+1.5V
−80dBm	+0.15V	+1.0V
−90dBm	+0.10V	+0.5V

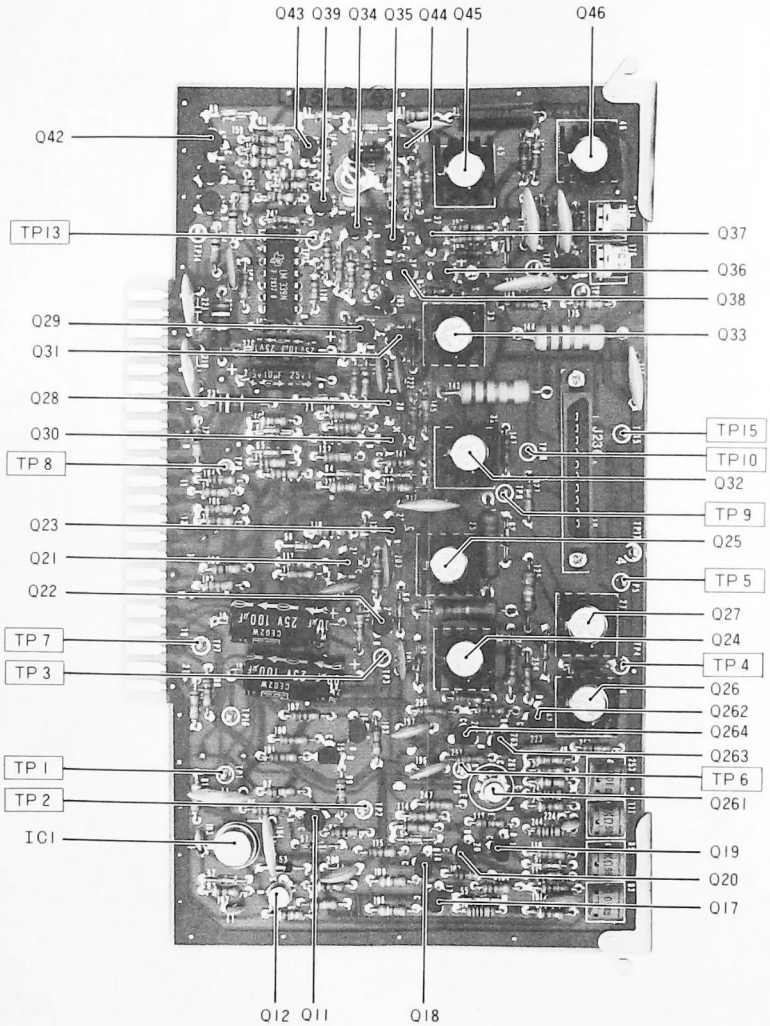


Fig. 7-15 SG178 (CRT DRIVER) Check Point

CHART—8 CRT DRIVER (SG178)

Settings
DISPERSION/DIV. ·····20MHz /DIV.
BAND WIDTH·····3MHz
REF. LEVEL ·····—30dBm
TIME/DIV.·····2ms/DIV.
VERT. MODE ·····2dB/DIV.
FREQUENCY·····200MHz

Connect CAL. OUT. and INPUT.

Connect oscilloscope to TP2. Verify normal waveform.
NO → Check circuits IC1, Q11, Q12.
YES

Connect oscilloscope to TP3. Verify normal waveform.
NO → Check circuits Q17 to Q20.
YES

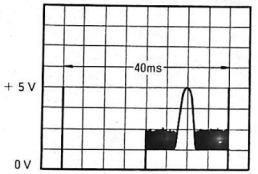
Connect oscilloscope to TP4, TP5. Verify normal waveforms.
NO → Check circuits Q21 to Q27.
YES

Connect oscilloscope to TP9, TP10. Verify normal waveforms.
NO → Check circuits Q28 to Q31.
YES

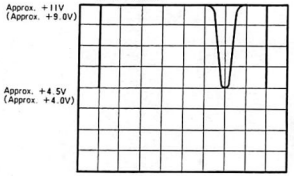
Connect oscilloscope to TP13. Verify normal waveform.
NO → Check circuits Q34 to Q38.
YES

Connect oscilloscope to TP15. Verify normal waveform.
NO → Check circuits Q39, Q42 to Q46.
YES

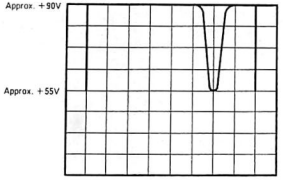
● TP 1



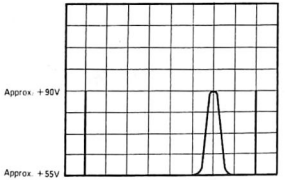
● TP2, (TP3)



● TP4

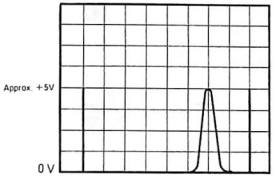


● TP5

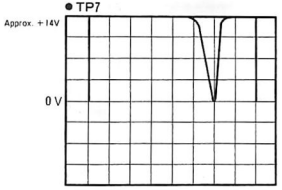


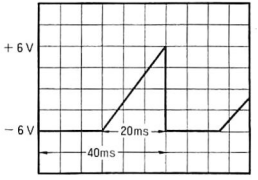
Connect oscilloscope to TP6. Verify normal waveform.
NO → Check Q261 to Q264.
YES → CRT driver is normal.

● TP6

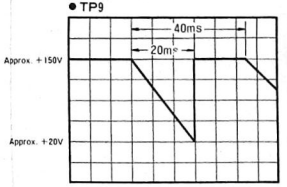


● TP7

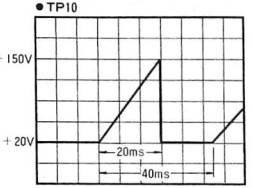




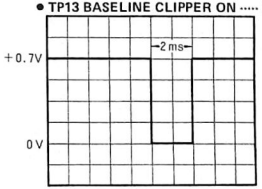
● TP9



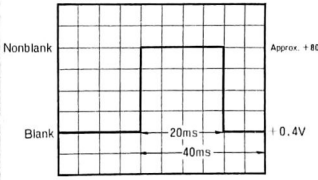
● TP10



● TP13 BASELINE CLIPPER ON ····· 0V



● TP15



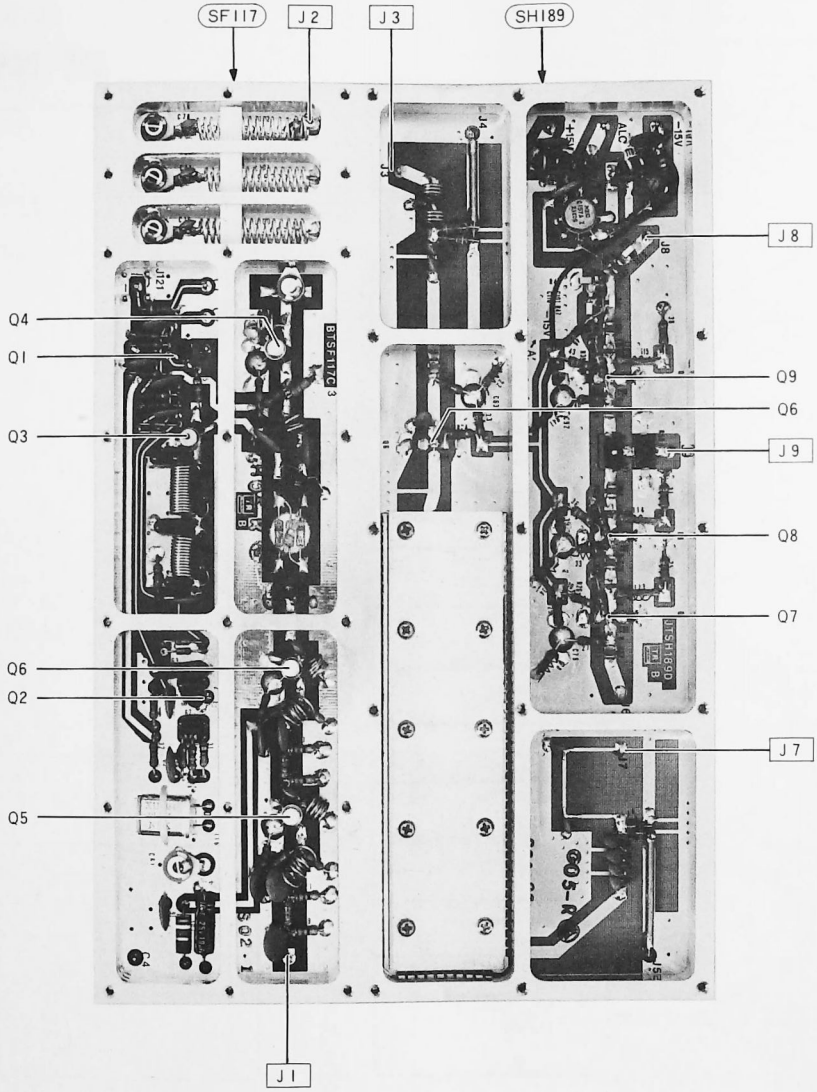
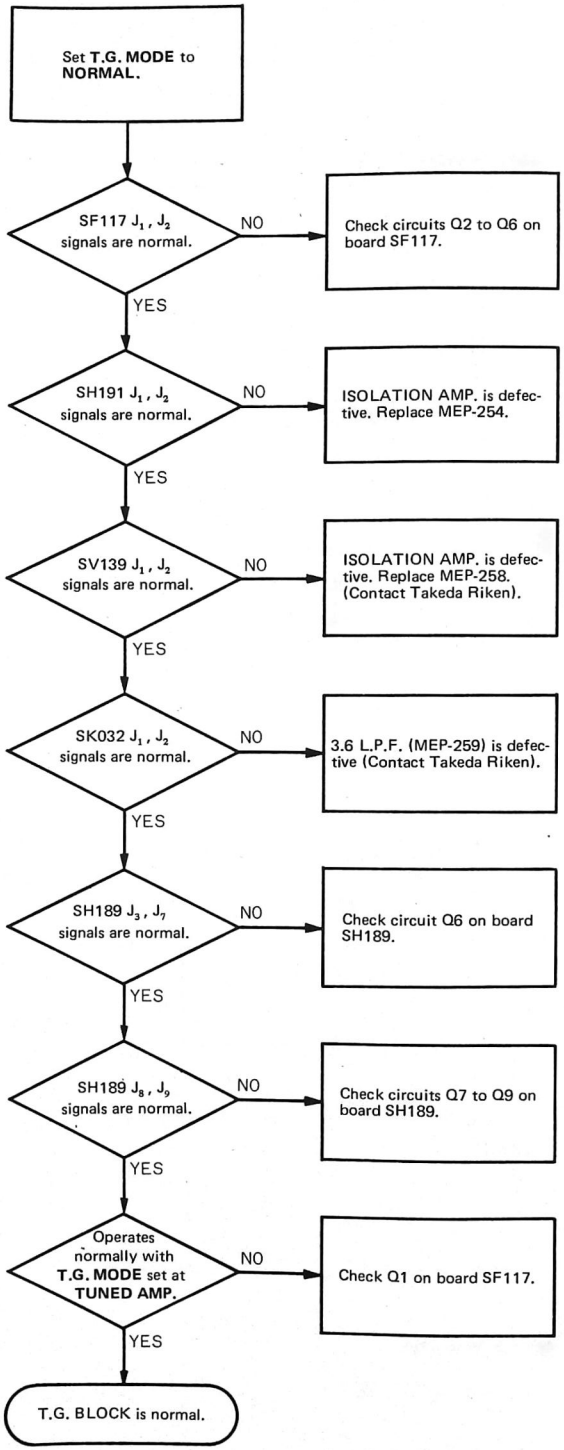


Fig. 7-16 MEP-257 TRACKING GENERATOR Check Point

CHART — 9 TRACKING GENERATOR BLOCK (MEP-257)


Set T.G. MODE to NORMAL.
SF117 J1 , J2 signals are normal.
NO
Check circuits Q2 to Q6 on board SF117.
YES
SH191 J1 , J2 signals are normal.
NO
ISOLATION AMP. is defective. Replace MEP-254.
YES
SV139 J1 , J2 signals are normal.
NO
ISOLATION AMP. is defective. Replace MEP-258. (Contact Takeda Riken).
YES
SK032 J1 , J2 signals are normal.
NO
3.6 L.P.F. (MEP-259) is defective (Contact Takeda Riken).
YES
SH189 J3 , J7 signals are normal.
NO
Check circuit Q6 on board SH189.
YES
SH189 J8 , J9 signals are normal.
NO
Check circuits Q7 to Q9 on board SH189.
YES
Operates normally with T.G. MODE set at TUNED AMP.
NO
Check Q1 on board SF117.
YES
T.G. BLOCK is normal.

- **Signal levels at each points (At ALC connector 0V)**
- **SF117**
  - J_1 : 200MHz Approx. +1dBm
  - J_2 : 210.7MHz Approx. -5dBm
- **SH191**
  - J_1 : 1.8GHz Approx. +3dBm
  - J_2 : 1.8GHz Approx. +8dBm
- **SV139**
  - J_1 : 2.05～3.55GHz Approx. 0dBm
  - J_2 : 2.05～3.55GHz Approx. +7dBm
- **SK032**
  - J_1 : 2.05～3.55GHz Approx. +7dBm
  - J_2 : 2.05～3.55GHz Approx. +7dBm
- **SH189**
  - J_3 : 210.7MHz Approx. -5dBm
  - J_7 : 0.4～1500MHz Approx. -18dBm
- **SH189**
  - J_8 : 0.4～1500MHz Approx. 0dBm
  - J_9 : 0.4～1500MHz Approx. -12dBm

Note) To replace MEP-254, MEP-258, MEP-259, see Item [7-3].

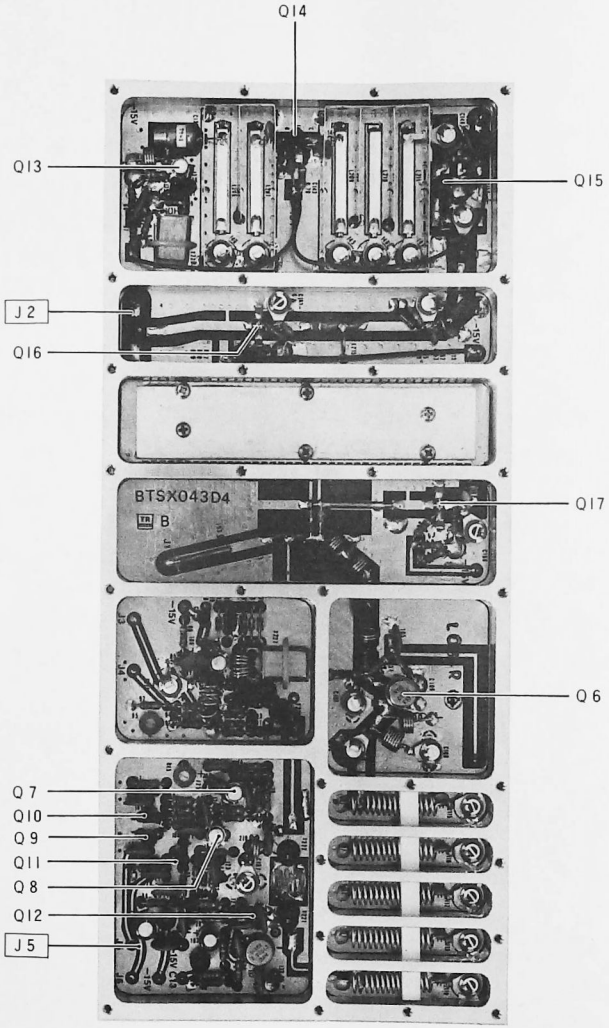
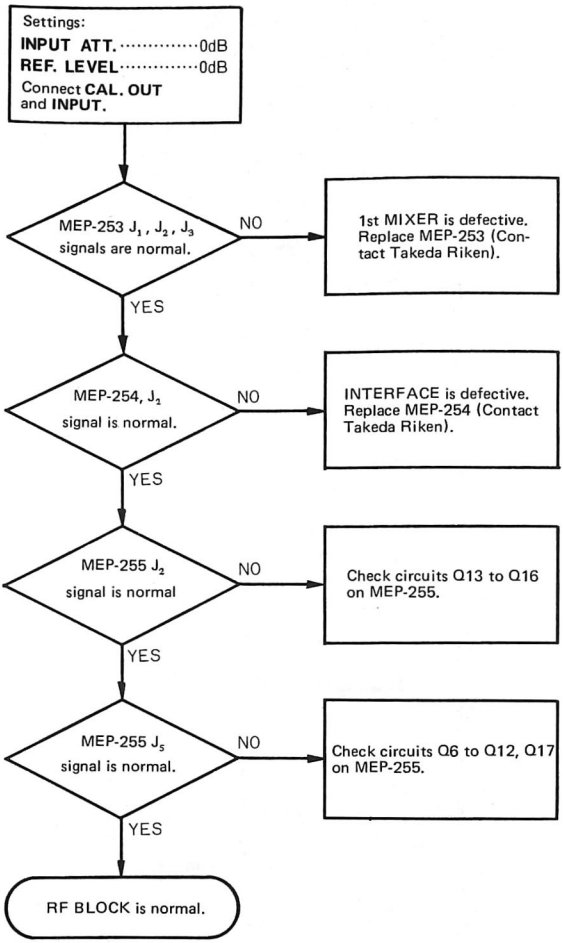


Fig. 7-17 MEP-255 RF Block Check Point

CHART—10 RF BLOCK (MEP-253, 254, 255)



- **MEP-253**
  - J_1 : 200MHz —30dBm
  - J_2 : 1.9~3.8GHz Approx. +10dBm
  - J_3 : 1.9~3.8GHz Approx. -40dBm
- **MEP-254**
  - J_2 : 2.05GHz Approx. -41dBm
- **MEP-255**
  - J_2 : 1.84GHz Approx. +2dBm
- **MEP-255**
  - J_5 : 10.7MHz Approx. -29dBm
  - J_3 : 200MHz Approx. +1dBm
  - J_4 : 200MHz —30dBm

Note) To replace MEP-253, MEP-254, see Item [7-3].

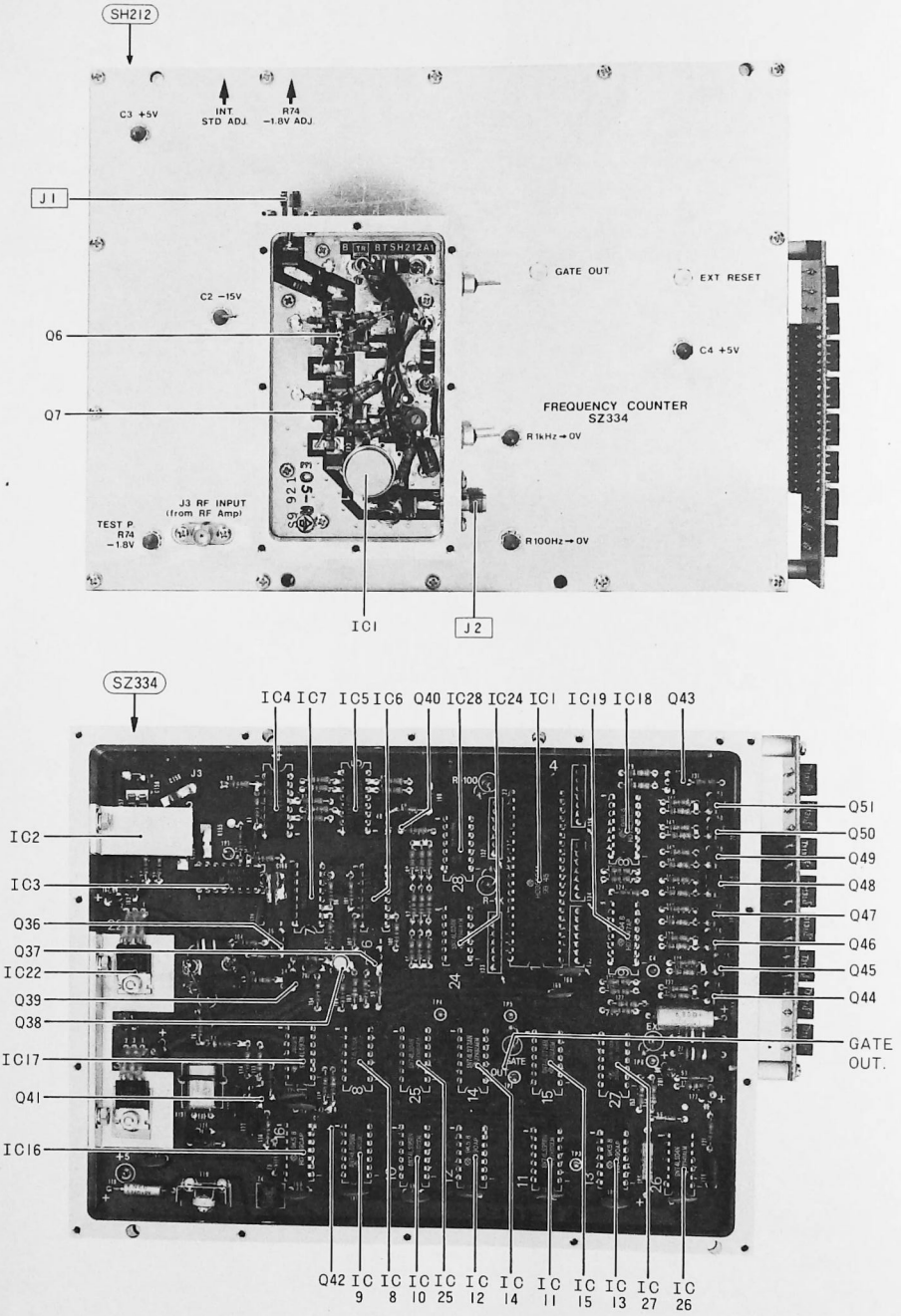
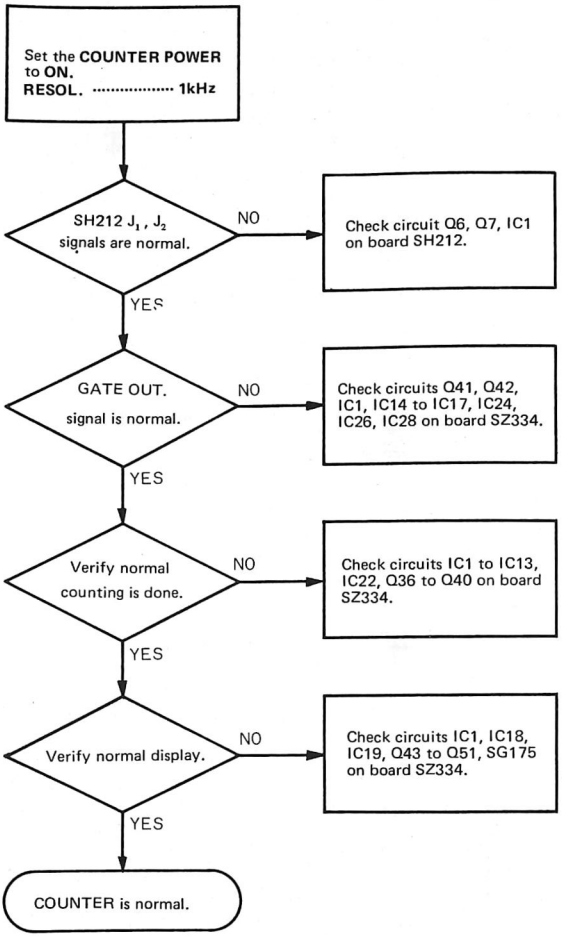


Fig. 7-18 MEP-260 FREQUENCY COUNTER Check Point

CHART — 11 FREQUENCY COUNTER (MEP-260)

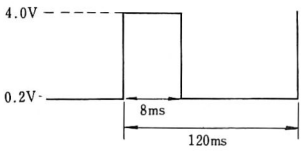

Set the COUNTER POWER to ON.
RESOL. 1kHz
SH212 J1 , J2 signals are normal.
NO
Check circuit Q6, Q7, IC1 on board SH212.
YES
GATE OUT. signal is normal.
NO
Check circuits Q41, Q42, IC1, IC14 to IC17, IC24, IC26, IC28 on board SZ334.
YES
Verify normal counting is done.
NO
Check circuits IC1 to IC13, IC22, Q36 to Q40 on board SZ334.
YES
Verify normal display.
NO
Check circuits IC1, IC18, IC19, Q43 to Q51, SG175 on board SZ334.
YES
COUNTER is normal.

- **SH212**

  J_1 : 0.4~1500MHz Approx. -12dBm

  J_2 : 0.4~1500MHz Approx. $0.2V_{p\text{-}p}$

- **SZ334 Gate Out.**



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8-1 Description

This section covers the electrical parts and mechanical parts used for **-TR-4122B** Spectrum Analyzer. It is suggested to use the parts of equivalent specifications or performance referring to the lists when replacing them due to failure.

In the case of the parts marked※ and also for mechanical parts contact Takeda Riken or its local distributer.

Please clearly mention the Parts No. and Stock No. for electrical parts and Name of the Parts and the Stock No. for mechanical parts when placing an order or for an inquiry.

The blocks listed below are replaced completely as units.

1	MEP-253	1st MIXER
2	MEP-254	INTERFACE
3	MEP-256	COUPLER
4	MEP-258	ISOLATION AMP.
5	MEP-259	ISOLATION FILTER
6	MTM5562	HIGH VOLTAGE BLOCK
7	TOP-1200	YIG TUNED OSC.
8	CRT	
9	MEP-267	ATTENUATOR

NOTE

The parts and specifications may be changed with or without notice following necessary modifications.

8-2 Simbols and Abbreviations

Table 8-1 shows the simbols and abbreviations as used in the Parts Lists and the Circuit Diagrams.

In the case the letters in the manual description means respective performance or function, the same style of the character as used in the printings on the panel of the instrument is applied for easier identification.

REFERENCE DESIGNATIONS	
C	Capacitor
CO	Coil
Ca	Cable
F	Fuse
FH	Fuse Holder
IC	Integrated Circuit
J	Electrical Connector, Jack
L	Coil, Inductor
Q	Transistor
R	Resistor
S	Switch (Slide, Lever, Push Button)
SW	Rotary Switch
T	Transformer
TP	Test Point (Check Point)
X	Crystal

MULTIPLIERS		
Abbreviation	Prefix	Multiple
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}

ABBREVIATIONS

A	ampere	dBm	decibel referred to 1mW
AC	alternating current	dBμ	decibel (0dBμ=1 μVrms.)
ADJ.	adjustment	DC	direct current
A/D	analog-to-digital	DET.	detector
AMP.	amplifier	DIV. (div.)	division
ATT.	attenuator	DISP.	dispersion
ASTIG.	astigmatism		
ANT.	antenna	ELECT	electolytic
AUTO	automatic, -operation	EXT.	external
BCD	binary coded decimal	F	farad
B.P.F.	bandpass filter	FET.	field-effect transistor
B.W.	band width	FM	frequency modulation
		FREQ.	frequency
CAR	carbon	FXD	fixed
CAL.	calibrate	FLM	film
CER	ceramic		
cm	centimeter	g	gram
COM.	common	GHz	gigahertz
CRT	cathode-ray tube	GND	ground
D/A	digital-to-analog	H	henry
dB	decibel	h	hour

Table 8 – 1 ABBREVIATIONS

HI	high
H.P.F.	high pass filter
Hz	Hertz
H.POSI.	Horizontal Position
H.GAIN	Horizontal Gain
IC	integrated circuit
IF	intermediate frequency
INT	internal
kg	kilogram
kHz	kilohertz
kΩ	kiloohm
kV	kilovolt
LED	light-emitting diode
LIN.	linear
LO	low, local oscillator
LOG.	logarithm
L.P.F.	low pass filter
LEV.	level
m	meter
mA	milliampere
MAX.	maximum
MΩ	megohm
mg	milligram
MHz	megahertz
MIN.	minimum
min.	minute (time)
mm	millimeter
MOD.	modulator
ms	millisecond
mV	millivolt
mVrms.	millivolt rms
mW	milliwatt
μA	microampere
μF	microfarad
μH	microhenry
μs	microsecond
μV	microvolt
μVrms.	microvolt rms
μW	microwatt
MANU.	manual
MIX.	mixer
NPN	negative-positive-negative
nA	nanoampere
NC	no connection
NORM.	normal
ns	nanosecond
nW	nanowatt
OPT.	option
OSC.	oscillator
Ω	ohm
OUT.	output
p	peak
pF	picofarad
PL	phase lock
PLO	phase lock oscillator
PM	phase modulation
p-p	peak-to-peak
PPM	pulse-position-modulation
PRF	pulse-repetition frequency
ps	picosecond
POSI.	position
PNP	positive-negative-positive
Q.P.	Quasi Peak Value
REF.	reference
RF	radio frequency
rms.	root-mean-square
SI	silicon
s	second (time)
S.G.	single generator
SSB	single sideband
S.W.R	standing-wave ratio
T	timed (slow-blow fuse)
TTL	transistor-transistor logic
TV	television
TP	test point
VAR	variable
V	volt
VA	voltampere
VCO	voltage-controlled oscillator
VFO	variable-frequency oscillator
Vp-p	volts peak-to-peak
Vrms.	volts rms
V.S.W.R.	voltage standing wave ratio
V.POSI.	vertical position
V.GAIN	vertical gain
W	watt
YIG.	yttrium-iron-garnet
1st.	the first
2nd.	the second
3rd.	the third

Table 8-1 ABBREVIATIONS

Parts No.	Stock No.	Description	
SS - R1	X13B 5KΩ	R: VAR WW 5kΩ	
" R2	X13B 5KΩ	R: VAR WW 5kΩ	
" R3	RJ-13B 200KΩ	R: VAR CERMET 200kΩ	
" R4	X13B 2KΩ	R: VAR WW 2kΩ	
" R5	X13B 2KΩ	R: VAR WW 2kΩ	
" R6	X13B 5KΩ	R: VAR WW 5kΩ	
" R7	RVE16YN15R4M	R: VAR CAR 4MΩ	
" R8	RVE16YN15R4M	R: VAR CAR 4MΩ	
" R9	RV16YN15SB	R: VAR CAR 1kΩ	
" R10	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" N1	BNF 2	Neon Lamp	
" D1	BD-701R	Light Emitting Diode	
" S1	RS-700A		
	1-1-6 L=20	Rotary Switch	※
" TL1	CRT-L2	L: CRT Coil	※
" J1	THDC-HRMJ-NJ	Connector	※
" J2	THDC-HRMJ-NJ	Connector	※
" J3	TOC-1B06060N	Connector	※
" J4	S-1612A	Connector	※
" J5	PCN6-10S-2.5E	Connector	※
" J6	TOC-2B12030N	Connector	※
" J7	50-673-0000-31	Connector	※
" J8	50-673-0000-31	Connector	※
" J9	P-1612BA	Connector	※
" J10	PCN6	Connector Lock	※
" J11	PCN6	Connector Lock	※
" P1	SCT-20L5NU3		※
SS - P2		Not assigned	

MEP-251 PANEL SECTION

Parts No.	Stock No.	Description	
MEP251 - R1	M1305 10KΩ	Potentio Meter	
" R2	RA25YN25SB 10KΩG	R: VAR CAR 10kΩ	
" R3	X-13B 2KΩ	R: VAR WW 2kΩ	
" S1	MFS-201N6	Slide Switch	※
" S2	YSNH-157D	Rotary Switch	※
" S3	MFS-201N6	Slide Switch	※
" S4	LS19P 1-3-3	Slide Switch	※
" S5	LS19P 1-2-4	Slide Switch	※
" S6	SL83	Slide Switch	※
" S7	MSP 103C	Push Button Switch	※
" J1	10-4	Connector	※
" J2	PCN6-5S-2.5E	Connector	※
" J3	PCN6	Connector Lock	※
MEP251 - J4	PCN6	Connector Lock	※

Parts No.	Stock No.	Description	
PB296 - IC1	SN74LS10N	IC: Triple 3-Input NAND Gate Low Power	
" IC2 thru " IC5	SN74LS30N	IC: 8-Input NAND Gate Low Power	
" IC6	SN74LS20N	IC: Dual 4-Input NAND Gate Low Power	
" IC7	SN74LS04N	IC: Hex Inverter Low Power	
" IC8	SN7406N	IC: Hex Inverter Buffer/Driver with Open-Collector High-Voltage Output	
" IC9 thru " IC12	SN74LS30N	IC: 8-Input NAND Gate Low Power	
" IC13	SN74LS05N	IC: Hex Inverter with Open-Collector Output Low Power	
" IC14	SN74LS05N	IC: Hex Inverter with Open-Collector Output Low Power	
" R21 thru " R23	TMR-103	R: FXD COM 10kΩ	
" R24	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" C31 thru " C35	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C36	25TH10	C: FXD ELECT 10μF 25V	
" C37	25TH10	C: FXD ELECT 10μF 25V	
" C38	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
PB296 - L41	TPF0410L-391K	L: FXD Coil 390μH	

Parts No.	Stock No.	Description	
PB295 - IC1 thru " IC4	SN74LS30N	IC: 8-Input NAND Gate	
" IC5	SN74LS10N	IC: Triple 3-Input NAND Gate	
" D15	SLP-24B	Light Emitting Diode	
" D16	SLP-224B	Light Emitting Diode	
" R21	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R22	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R23	RD25S 3.9KΩJ	R: FXD CAR 3.9kΩ ±5% 1/4W	
" R24	RD25S 3.9KΩJ	R: FXD CAR 3.9kΩ ±5% 1/4W	
" R25	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R26	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" C31 thru " C33	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" S41	YSNH-155B	Rotary Switch	※
PB295 - S42	YSNH-154B	Rotary Switch	※

Parts No.	Stock No.	Description	
PB297 - IC1	IM5623	IC: 1024-Bit Programmable ROM	※
" IC2	IM5623	IC: 1024-Bit Programmable ROM	※
" IC3	SN74LS85N	IC: 4-Bit Magnitude Conparator Low Power	
" IC4	SN74LS157N	IC: Quad 2-to-Line Data Selector/ Multiplexer Low Power	
" IC5	IM5600CPE	IC: 256-Bit ROM	※
" IC6	SN74LS20N	IC: Dual 4-Input NAND Gate Low Power	
" IC7	SN74LS00N	IC: Quadruple 2-Input NAND Gate Low Power	
" IC8	SN74LS05N	IC: Hex Inverter with Open-Collector Output Low Power	
" R11	TMR6-103	R: FXD COM 10kΩ	※
" R12	TMR6-103	R: FXD COM 10kΩ	※
" C16	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C17	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" J21	152-22-50-169-1	Connector	※
PB297 - J22	152-14-50-169-1	Connector	※

Parts No.	Stock No.	Description	
	SE159	Switch Board	
	SE160	Regulator Board	
MEP252 - IC	SI-3552M	IC: Voltage Regulator	
" Q1 thru " Q3	2SD82	Transistor SI NPN	
" Q4	2SC515A	Transistor SI NPN	
" D1 thru " D3	VH247	Diode	
" R1	RH-100.4ΩK	R: FXD WW 100.4Ω	
" R2	RH-100.4ΩK	R: FXD WW 100.4Ω	
" C1	111M2502 106M	C: FXD ELECT TANTAL 10μF ±20% 25V	
" C2	111M1002 475M	C: FXD ELECT TANTAL 4.7μF ±20% 10V	
" C3 thru " C5	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C6	0.022UF 500WV	C: FXD CER 0.022μF +80, -20% 500V	
" LF1	NF-13502	Noise Filter	
" P1	TOP-23A	Terminal	※
" FH1	FH-003	Fuse Holder	※
" F1	EAWK 1A	Fuse	※
" T1	TP-1036B	Power Transformer	※
" J1	JRC21RG-16S	Connector	※
MEP252 - J2	JRC21RC	Connector Cup	※

Parts No.	Stock No.	Description	
SE159 - D1	W02	Diode SI	
" D2	MI-151	Diode SI	
" D3	MI-151R	Diode SI	
" R6	RD25S 390ΩJ	R: FXD CAR 390Ω ±5% 1/4W	
" R7	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" C11	16VP-10000	C: FXD ELECT 10000μF 16V	
" C12	35VP-4700	C: FXD ELECT 4700pF 35V	
" C13	35VP-4700	C: FXD ELECT 4700pF 35V	
" C14	50VP-2200	C: FXD ELECT 2200pF 50V	
" C15	250LASN100	C: FXD ELECT 100pF 250V	
" S21	1PFS-2U 470-010-01-00	Switch	※
" S22	1PFS-2U 470-010-01-00	Switch	※
SE159 - J25	B65532-406	Connector	※

Parts No.	Stock No.	Description	
SE160 - IC1	LM723CH	IC: Voltage Regulator	
" IC2	LM723CH	IC: Voltage Regulator	
" Q6 thru " Q8	2SC1279S	Transistor SI NPN	
" Q9	2SC505	Transistor SI NPN	
" Q10	2SC1279S	Transistor SI NPN	
" D16 thru " D18	WZ-061	Zener Diode	
" R21	CRB 1/4FX 3.3KΩ	R: FXD Metal FLM 3.3kΩ ±1% 1/4W	
" R22	X-6T 1KΩ	R: VAR WW 1kΩ	
" R23	CRB 1/4FX 3.0KΩ	R: FXD Metal FLM 3.0kΩ ±1% 1/4W	
" R24	CRB 1/4FX 3.3KΩ	R: FXD Metal FLM 3.3kΩ ±1% 1/4W	
" R25	X-6T 1KΩ	R: VAR WW 1kΩ	
" R26	CRB 1/4FX 3.0KΩ	R: FXD Metal FLM 3.0kΩ ±1% 1/4W	
" R27	RD50S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/2W	
" R28	RW-1-1ΩJ	R: FXD CAR 1Ω ±5% 1W	
" R29	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R30	RD50S 3.9KΩJ	R: FXD CAR 3.9kΩ ±5% 1/2W	
" R31	CRB 1/4FX 20KΩ	R: FXD Metal FLM 20kΩ ±1% 1/4W	
" R32	X-6T 2KΩ	R: VAR WW 2kΩ	
" R33	CRB 1/4FX 5.6KΩ	R: FXD Metal FLM 5.6kΩ ±1% 1/4W	
" R34	R-1 47KΩJ	R: FXD CAR 47kΩ ±5% 1W	
" R35	RD50S 10ΩJ	R: FXD CAR 10Ω ±5% 1/2W	
" R36	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R37	R-1 68KΩJ	R: FXD CAR 68kΩ ±5% 1W	
" R38	CRB 1/4FX 130KΩ	R: FXD Metal FLM 130kΩ ±1% 1/4W	
" R39	X-6T 10KΩ	R: VAR WW 10kΩ	
" R40	CRB 1/4FX 8.2KΩ	R: FXD Metal FLM 8.2kΩ ±1% 1/4W	
" R41	RD25S 68KΩJ	R: FXD CAR 68kΩ ±5% 1/4W	
" R42	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
SE160 - C46	DM15D511J3	C: FXD DIPPED MICA 510pF ±5% 300V	

Parts No.	Stock No.	Description	
SE160 - C47	DM15D511J3	C: FXD DIPPED MICA 510pF ±5% 300V	
" C48	111M3502-226M	C: FXD ELECT TANTAL 22μF ±20% 35V	
" C49	111M3502-226M	C: FXD ELECT TANTAL 22μF ±20% 35V	
" C50	50T33	C: FXD ELECT 33μF 50V	
" C51	25T100	C: FXD ELECT 100μF 25V	
" C52	25T100	C: FXD ELECT 100μF 25V	
" L55	TPF0410L-331K	L: FXD Coil 330μH	
" L56	TPF0410L-331K	L: FXD Coil 330μH	
SE160 - L57	LT-D200	L: FXD Coil	※
	401-9630	Terminal	※

Parts No.	Stock No.	Description	
MZ337 - J1 thru " J6	152-22-50-169-1	Connector	※
" J7	57-40500	Connector	※
" J8	PBRS-60-T2	Connector	※
" J9	TOC-1B06030N	Connector	※
" J10	PCN6B-10P-2.5DS	Connector	※
" J11		Not assigned	
" J12 thru " J14	BNC-078	Connector	※
" R21	X-13B 20KΩ	R: VAR WW 20kΩ	
" R22	X-13B 20KΩ	R: VAR WW 20kΩ	
" R23	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
MZ337 - R24	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
	SA041	ATTENUATION BOARD	
	SP014	ATT. CONTROL	

Parts No.	Stock No.	Description	01	02
SP014 - IC1	SN7416	IC: Hex Inverter Buffer / Driver with Open - Collector High - Voltage Output	1	1
" - IC2	SN74LS04	IC: Hex Inverter Low power	1	1
" - IC3	SN74LS10	IC: Triple 3 - Input NAND Gate	0	1
" - D6	DAN401	Diode SI COM	1	1
" - D7	DAN401	Diode SI COM	1	1
" - D8 thru " - D11		Not assigned		
" - R13	TMR6-103	R: FXD COM 10kΩ	0	1
" - C16	TAXB 1602-226M	R: FXD ELECT TANTAL 22uF ±20% 10V	1	1
" - C17	TAXB 1602-226M	R: FXD ELECT TANTAL 22uF ±20% 10V	1	1
" - C18	0.01UF 50WV	R: FXD CER 0.01uF +80, -20% 50V	1	1
" - L21	TPF 0410L-391K	L: FXD Coil 390uH	1	1
" - J26	B65532-406	Connector	1	0
" - J27	B65532-406	Connector	0	1
SP014 - J28	B65520-406	Connector	0	1

Parts No.	Stock No.	Description	
SA041 - KCA1 thru " KCA3	MXK-0153-0112-1	Coaxial piece	
" - R1	THP-002A-10	Pad Card	
" - R2	THP-002A-20	Pad Card	
" - R3	THP-002A-20	Pad Card	
" - K1 thru " - K12	RD-18-1035	Reed Switch	
" - KL1 thru SA041 - KL12	LX-4A	Drive Coil Reed Switch	

MEP-253 1st. MIXER

Parts No.	Stock No.	Description	
	SF118	1st Mixer	
MEP253 - J1 thru MEP253 - J3	50-645-4545-31	Connector	※

Parts No.	Stock No.	Description	
SF118 - D1	D4007	Diode	
" R6	THP-007-3	3dB PAD	※
" R7	CHR-2-50ΩJ	R: FXD CHIP 50Ω ±5% 1/16W	
SF118 - C11	C35NP01H470K	C: FXD CHIP 470k ±10% 35V	
	MCT-219	Cable	

Parts No.	Stock No.	Description	
	SF120	Interface	
MEP254 - J1	50-645-4545-31	Connector	※
" J2	50-645-4545-31	Connector	※
" J3	50-645-4526-89	Connector	※
" J4	50-645-4526-89	Connector	※
" C1	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	
MEP254 - C2	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	

Parts No.	Stock No.	Description	
SF120 - Q1	FJ901F	Transistor SI NPN	
" R6	CHR-2-50ΩJ	R: FXD CHIP 50Ω ±5% 1/16W	
" R7	CHR-2-50ΩJ	R: FXD CHIP 50Ω ±5% 1/16W	
" R8	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R9	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R10	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R11	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" C21	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C22	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C23	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C24	ECV-1ZW06X31	C: VAR CER 6pF	
" C25	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C26	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C27	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C28		Not assigned	
SF120 - C29	111M2502-106M	C: FXD ELECT TANTAL 10μF ±20% 25V	

Parts No.	Stock No.	Description	
SH191 - Q1	FJ901F	Transistor SI NPN	
" Q2	FJ901F	Transistor SI NPN	
" R6	THP-007-6	6dB PAD	※
" R7	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R8	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R9	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R10	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R11	THP-007-3	3dB PAD	※
" R12	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R13	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R14	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R15	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" C21	C35BX1H103K	C: FXD CHIP 0.01μF ±10% 50V	
" C22	C35BX1H103K	C: FXD CHIP 0.01μF ±10% 50V	
" C23		Not assigned	
" C24	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C25 thru " C28	C35BX1H103K	C: FXD CHIP 0.01μF ±10% 50V	
" C29		Not assigned	
" C30	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C31	C35BX1H103K	C: FXD CHIP 0.01μF ±10% 50V	
" C32	C35BX1H103K	C: FXD CHIP 0.01μF ±10% 50V	
" L41		L: FXD Coil	
SH191 - L42		L: FXD Coil	

Parts No.	Stock No.	Description	
MEP255 - J1 thru " J3	50-645-4526-89	Connector	※
" J4 thru " J6	UM-QR-1	Connector	※
" C11 thru " C18	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	
" R21	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
MEP255 - R22	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	

Parts No.	Stock No.	Description	
SX043 - IC1	LM301A	IC: Operational Amplifier	
" Q6	2SC1426	Transistor SI NPN	
" Q7	2SC1254	Transistor SI NPN	
" Q8	2SC1254	Transistor SI NPN	
" Q9 thru " Q11	2SC1834	Transistor SI NPN	
" Q12	2SA1015	Transistor SI PNP	
" Q13	2SC1254	Transistor SI NPN	
" Q14	2SC2026	Transistor SI NPN	
" Q15	2SC2026	Transistor SI NPN	
" Q16	FJ201F	Transistor SI NPN	
" Q17	FJ201F	Transistor SI NPN	
" Q18	2SC1254	Transistor SI NPN	
" Q19	2SA1015	Transistor SI PNP	
" D21 thru " D26	1SS43	Diode SI	
" D27	5082-3379	Diode SI	
" D28	WZ-100	Zener Diode	
" D29	SV14B	Diode SI	
" D30	1S953	Diode SI	
" D31	1S953	Diode SI	
" D32	WZ-110	Zener Diode	
" R36	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R37	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R38	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R39	RD25S 22ΩJ	R: FXD CAR 22Ω ±5% 1/4W	
" R40	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R41	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R42 thru " R44	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
SX043 - R45	X6T 20ΩJ	R: VAR WW 20Ω	

Parts No.	Stock No.	Description	
SX043 - R46	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R47	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R48	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R49	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R50	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R51	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R52	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R53		Not assigned	
" R54	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R55	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R56	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R57	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R58	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R59	RD25S 220KΩJ	R: FXD CAR 220kΩ ±5% 1/4W	
" R60	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R61	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R62	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R63	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R64	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R65	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R66	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R67	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R68	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R69	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R70	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R71	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R72	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R73	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R74	THP-007-6	6dB PAD	※
" R75	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R76	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R77	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R78	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
SX043 - R79	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	

Parts No.	Stock No.	Description	
SX043 - R80	THP-003A	3dB PAD	※
" R81	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R82	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R83	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R84	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R85	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R86	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R87	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R88	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R89	RD25S 82ΩJ	R: FXD CAR 82Ω ±5% 1/4W	
" R90	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R91	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R92	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R93	RD25S 68ΩJ	R: FXD CAR 68Ω ±5% 1/4W	
" R94	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R95	X6T 50Ω	R: VAR WW 50Ω	
" R96	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R97	RD25S 56ΩJ	R: FXD CAR 56Ω ±5% 1/4W	
" R98	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R99	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R100	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" C101	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C102	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C103	12PF 50WV	C: FXD CER 12pF ±10% 50V	
" C104	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C105	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C106	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C107 thru C109	ECV-1ZW10X31	C: VAR CER 10pF	
" C110 thru SX043 C114	3PF 50WV	C: FXD CER 3pF ±10% 50V	

Parts No.	Stock No.	Description	
SX043 - C115 thru " C119	ECV-1ZW06X31	C: VAR CER 6pF	
" C120 thru " C124	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C125		Not assigned	
" C126		Not assigned	
" C127 thru " C129	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C130	150PF 50WV	C: FXD CER 150pF ±10% 50V	
" C131	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C132	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C133	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C134	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C135	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C136	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C137	DM10C050K5	C: FXD DIPPED MICA 5pF ±10% 500V	
" C138	DM10C070K5	C: FXD DIPPED MICA 7pF ±10% 500V	
" C139	TTA43A100	C: VAR CER 10pF ±0.05% 250V	
" C140	ECV-1ZW10X31	C: VAR CER 10pF	
" C141	ECV-1ZW10X31	C: VAR CER 10pF	
" C142	3PF 50WV	C: FXD CER 3pF ±10% 50V	
" C143	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C144	3PF 50WV	C: FXD CER 3pF ±10% 50V	
" C145 thru " C148	ECV-1ZW10X31	C: VAR CER 10pF	
" C149	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C150	ECV-1ZW10X31	C: VAR CER 10pF	
" C151	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C152	3PF 50WV	C: FXD CER 3pF ±10% 50V	
" C153	ECV-1ZW10X31	C: VAR CER 10pF	
" C154	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C155	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
SX043 - C156	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	

Parts No.	Stock No.	Description	
SX043 - C157	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C158	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C159	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C160	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C161	ECV-1ZW06X31	C: VAR CER 6pF	
" C162	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C163	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C164 thru " C167	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C168	ECV-1ZW06X31	C: VAR CER 6pF	
" C169	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C170	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C171	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C172	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C173	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C174	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C175	ECV-1ZW10X31	C: VAR CER 10pF	
" C176	DM10C070K5	C: FXD DIPPED MICA 7pF ±10% 500V	
" C177	DM10C070K5	C: FXD DIPPED MICA 7pF ±10% 500V	
" C178	DM10C150K5	C: FXD DIPPED MICA 15pF ±10% 500V	
" C179	DM10C100K5	C: FXD DIPPED MICA 10pF ±10% 500V	
" C180	22PF 50WV	C: FXD CER 22pF ±10% 50V	
" C181	DM10C150K5	C: FXD DIPPED MICA 15pF ±10% 500V	
" C182	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C183	25VBSN10	C: FXD ELECT 10μF 25V	
" C184	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C185	25VBSN10	C: FXD ELECT 10μF 25V	
" C186	221M3502-106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C187	ECV-1ZW06X31	C: VAR CER 6pF	
" C188	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C189	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C190	3PF 50WV	C: FXD CER 3pF ±10% 50V	
SX043 - L191	CSL0609-181K	L: FXD Coil 180μH	

Parts No.	Stock No.	Description	
SX043 - L192	CSL0609-181K	L: FXD Coil 180μH	
" L193		Not assigned	
" L194	LS20	L: FXD Coil 3T	※
" L195	LS20	L: FXD Coil 3T	※
" L196	LS19	L: FXD Coil 2T	※
" L197	LS21	L: FXD Coil 4T	※
" L198	LS23	L: FXD Coil 6T	※
" L199 thru " L203	MMS-007-0192-9	L: Inductance	※
" L204		Not assigned	
" L205		Not assigned	
" L206	MMB-0331-0142-1	L: Inductance	※
" L207	MMB-0331-0142-1	L: Inductance	※
" L208	LS17	L: FXD Coil 1T	※
" L209 thru " L211	MMB-0331-0142-1	L: Inductance	※
" L212	LS17	L: FXD Coil 1T	※
" L213	LS17	L: FXD Coil 1T	※
" L214	CSL0609-181K	L: FXD Coil 180μH	
" L215		**L: FXD Coil Wire**	
" L216	LS21	L: FXD Coil 4T	※
" L217	LS23	L: FXD Coil 6T	※
" L218	LS19	L: FXD Coil 2T	※
" L219	LS21	L: FXD Coil 4T	※
" T221	TP-865	Core	※
" T222	TP-865	Core	※
" T223	TP-864	Core	※
" X226	XU-083	Crystal	※
" X227	XU-082	Crystal	※
SX043 - C231	3PF 50WV	C: FXD CER 3pF ±10% 50V	
	A-105	Hermetic Seal	※

Parts No.	Stock No.	Description	
SX043 - R241	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" R242	RD25S 10ΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
	MXP-0123-0183-3	Coil Holder	※
" FB251	Q5BRH3.4X3X1	Fuse	※
SX043 - FB252	Q5BRH3.4X3X1	Fuse	※

Parts No.	Stock No.	Description	
	SZ335	Coupler	
MEP256 - TM1	HRM-601A		※
" J1 thru MEP256 - J3	50-645-4545-31	Connector	※

Parts No.	Stock No.	Description	
SZ335 - R1	CHR-2-50ΩJ	R: FXD CHIP 50Ω ±5% 1/16W	

Parts No.	Stock No.	Description	
MEP257 - J1 thru " J9	50-645-4526-89	Connector	※
" C1 thru MEP257 - C7	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	

Parts No.	Stock No.	Description	
SF117 - Q1	2SC1834	Transistor SI NPN	
" Q2	2SC1834	Transistor SI NPN	
" Q3	ITS30088B	FET Junction N-Channel	
" Q4 thru " Q6	2SC1254	Transistor SI NPN	
" D11 thru " D14	1S953	Diode SI	
" D15 thru " D18	1SS43	Diode SI	
" R21	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R22	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R23	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R24	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R25	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R26	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R27	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R28	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R29	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R30	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R31 thru " R34	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R35	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R36	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R37	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R38	RD25S 560ΩJ	R: FXD CAR 560 ±5% 1/4W	
" R39	RD25S 68ΩJ	R: FXD CAR 68Ω ±5% 1/4W	
" R40	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R41	RD25S 68ΩJ	R: FXD CAR 68Ω ±5% 1/4W	
" R42	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R43	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
SF117 - R44	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	

Parts No.	Stock No.	Description	
SF117 - R45	RD25S 68ΩJ	R: FXD CAR 68Ω ±5% 1/4W	
" R46	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R47	RD25S 68ΩJ	R: FXD CAR 68Ω ±5% 1/4W	
" R48	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R49	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R50	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" C56 thru " C60	0.01UF 50WV	C: FXD CAR 0.01μF +80, -20% 50V	
" C61	ECV-1ZW70X31	C: VAR CER 70pF	
" C62	DM10D221J3	C: FXD DIPPED MICA 220pF ±5% 300V	
" C63	DM19D222J5	C: FXD DIPPED MICA 2200pF ±5% 500V	
" C64	DM10D121J3	C: FXD DIPPED MICA 120pF ±5% 300V	
" C65	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C66	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C67	DM10D301J3	C: FXD DIPPED MICA 300pF ±5% 300V	
" C68	DM10D151J3	C: FXD DIPPED MICA 150pF ±5% 300V	
" C69	DM15D471J3	C: FXD DIPPED MICA 470pF ±5% 300V	
" C70	DM10D510J3	C: FXD DIPPED MICA 51pF ±5% 300V	
" C71	DM15D391J5	C: FXD DIPPED MICA 390pF ±5% 500V	
" C72	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C73	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C74	ECV-1ZW10X31	C: VAR CER 10pF	
" C75	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C76 thru " C78	3PF 50WV	C: FXD CER 3pF ±10% 50V	
" C79 thru " C81	ECV-1ZW06X31	C: VAR CER 6pF	
" C82	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C83	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C84	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C85	6.8PF 50WV	C: FXD CER 6.8pF ±10% 50V	
SF117 - C86	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	

Parts No.	Stock No.	Description	
SF117 - C87	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C88	6.8PF 50WV	C: FXD CER 6.8pF ±10% 50V	
" C89 thru " C91	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C92	25TH10	C: FXD ELECT 10μF 25V	
" L96	LS30	L: FXD Coil 13T	※
" L97	LS33	L: FXD Coil 16T	※
" L98	LS19	L: FXD Coil 2T	※
" L99	LS21	L: FXD Coil 4T	※
" L100 thru " L102	MMS-0007-0192-9	L: FXD Coil 15T	※
" L103 thru " L106	LS21	L: FXD Coil 4T	※
" L107	TPF0410L-391K	L: FXD Coil 390μH	
" T111	TP865	Core	※
" T112	TP865	Core	※
" X116	XU-084	Crystal	※
SF117 - J121	UM-R-PC	Connector	※
	MXP-0124-0182-2	Coil Holder	※

Parts No.	Stock No.	Description	
SH189 - IC1	LM301A	IC: Operational Amplifier	
" Q6	FJ901F	Transistor SI NPN	
" Q7	FJ201F	Transistor SI NPN	
" Q8	FJ901F	Transistor SI NPN	
" Q9	FJ901F	Transistor SI NPN	
" D11 thru " D14	1SS43	Diode SI	
" D15	5082-2520	Diode SI	
" R21	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R22	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R23	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R24	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R25	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R26	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R27	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R28	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R29	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R30	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R31	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R32	RD25S 180ΩJ	R: FXD CAR 180Ω ±5% 1/4W	
" R33	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R34	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R35	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R36	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R37	THP-003A	3dB PAD	※
" R38	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R39	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R40	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R41	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R42	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R43	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
SH189 - R44	CHR-2 22ΩJ	R: FXD CHIP 22Ω ±5% 1/16W	

Parts No.	Stock No.	Description	
SH189 - R45	CHR-2 50ΩJ	R: FXD CHIP 50Ω ±5% 1/16W	
" R46	CHR-2 120ΩJ	R: FXD CHIP 120Ω ±5% 1/16W	
" R47	CHR-2 39ΩJ	R: FXD CHIP 39Ω ±5% 1/16W	
" R48	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R49	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R50	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R51	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R52	RD25S 39KΩJ	R: FXD CAR 39kΩ ±5% 1/4W	
" R53	X6T 1KΩ	R: VAR WW 1kΩ	
" R54	CHR-2 22ΩJ	R: FXD CHIP 22Ω ±5% 1/16W	
" R55	THP007-6	6dB PAD	※
" C56	12PF 50WV	C: FXD CER 12pF ±10% 50V	
" C57	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C58	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C59	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C60	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C61		Not assigned	
" C62	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C63	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C64	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C65	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C66 thru " C69	1PF 50WV	C: FXD CER 1pF ±10% 50V	
" C70	2PF 50WV	C: FXD CER 2pF ±10% 50V	
" C71	2PF 50WV	C: FXD CER 2pF ±10% 50V	
" C72	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C73	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C74		Not assigned	
" C75		Not assigned	
" C76	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C77	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C78	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
SH189 - C79	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	

Parts No.	Stock No.	Description	
SH189 - C80	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C81	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C82	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C83	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C84	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C85	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C86	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C87	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C88	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C89	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C90		Not assigned	
" C91		Not assigned	
" C92	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C93	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C94	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C95	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C96	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C97	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C98	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C99	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C100	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C101	C35NP01H010C	C: FXD CHIP 1pF ±0.25% 50V	
" C102	330PF 50WV	C: FXD CER 330pF ±10% 50V	
" C103	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C104		Not assigned	
" C105		Not assigned	
" C106 thru C109	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C110	7263	C: VAR Teflon 1.2pF	
" L111	LS20	L: FXD Coil 3T	※
" L112	LS20	L: FXD Coil 3T	※
" L113 thru SH189 L115	L-0005	L: FXD Coil 0.4μH	※

Parts No.	Stock No.	Description	
SH189 - L116	TPF0410L-391K	L: FXD Coil 390μH	
" L117	TPF0410L-391K	L: FXD Coil 390μH	
SH189 - C131	C35NP01H470K	C: FXD CHIP 47pF ±10% 50V	

Parts No.	Stock No.	Description	
MEP258 - J1	50-645-4526-89	Connector	※
" J2	50-645-4526-89	Connector	※
MEP258 - C1	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	

Parts No.	Stock No.	Description	
SV139 - Q1 thru " Q3	FJ901F	Transistor SI NPN	
" R6	THP-007-3	3dB PAD	※
" R7	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R8	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R9	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R10	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R11	THP-007-3	3dB PAD	※
" R12	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R13	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R14	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R15	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R16	THP-007-3	3dB PAD	※
" R17	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R18	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R19	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R20	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" C26	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C27	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C28	7263	C: VAR Teflon 1.2pF	
" C29	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C30 thru " C33	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C34	7263	C: VAR Teflon 1.2pF	
" C35	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C36 thru " C39	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C40	7263	C: VAR Teflon 1.2pF	
" C41	BLM1H472NA	C: FXD BL 4700pF ±0.05% 50V	
" C42	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
SV139 - C43	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	

Parts No.	Stock No.	Description	
MEP259 - J1	50-645-4545-31	Connector	
MEP259 - J2	50-645-4545-31	Connector	

Parts No.	Stock No.	Description	
MEP260 - J1 thru " J3	50-645-4526-89	Connector	※
" C1 thru MEP260 - C8	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	

Parts No.	Stock No.	Description	
SZ334 - IC1	HD35504A	IC: MOS LSI	※
" IC2	SP8619B	IC: High Sneed 1/4 divider	
" IC3	11C06DC	IC: 750MHz	
" IC4	MC1662L	IC: Quadruple 2-Input NOR Gate	
" IC5	MC10231L	IC: Dual Type D-Master-Slave Flip-Flop	
" IC6	MC10131L	IC: Dual type D-Master-Slave Flip-Flop	
" IC7	MC10131L	IC: Dual type D-Master-Slave Flip-Flop	
" IC8	SN74LS86	IC: Quadruple 2-Input Exclusive OR-Gate Low Power	
" IC9 thru " IC11	SN74LS95	IC: 4-Bit Shift Register Low Power	
" IC12	SN74LS90	IC: Decade Counter Low Power	
" IC13	SN74LS90	IC: Decade Counter Low Power	
" IC14	SN74LS73	IC: Dual J-K Master-Slave Flip-Flop Low Power	
" IC15	SN74LS73	IC: Dual J-K Master-Slave Flip-Flop Low Power	
" IC16	SN74LS90	IC: Decade Counter Low Power	
" IC17	SN74LS93	IC: 4-Bit Binary Counter Low Power	
" IC18	SN74LS42	IC: BCD-to-Decimal Decoder Low Power	
" IC19	SN7447A	IC: BCD-to-Seven-Segment Decoder/Driver with 15V Output	
" IC20		Not assigned	
" IC21		Not assigned	
" IC22	FS-7905M	IC: Voltage Regulator	
" IC23	FS-7905M	IC: Voltage Regulator	
" IC24 thru " IC26	SN74LS04	IC: Hex Inverter Low Power	
SZ334 - IC27	SN74LS00	IC: Quadruple 2-Input NAND Gate Low Power	

Parts No.	Stock No.	Description	
SZ334 - IC28	SN74LS00	IC: Quadruple 2-Input NAND Gate Low Power	
" Q36	2SA1015	Transistor SI PNP	
" Q37	2SA1015	Transistor SI PNP	
" Q38	2N2894	Transistor SI PNP	
" Q39	2SC1834	Transistor SI NPN	
" Q40	2SA1015	Transistor SI PNP	
" Q41 thru " Q43	2SC1834	Transistor SI NPN	
" Q44 thru " Q51	2SA642	Transistor SI PNP	
" D56	1N704A	Diode SI	
" D57 thru " D60	1S953	Diode SI	
" R71	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R72	RD25S 270ΩJ	R: FXD CAR 270Ω ±5% 1/4W	
" R73	CRB 1/4FX 120Ω	R: FXD Metal FLM 120Ω ±1% 1/4W	
" R74	X6S 100Ω	R: VAR WW 100Ω	
" R75	CRB 1/4FX 10Ω	R: FXD Metal FLM 10Ω ±1% 1/4W	
" R76	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R77	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R78 thru " R80	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R81	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R82 thru " R88	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R89 thru " R91	RD25S 180ΩJ	R: FXD CAR 180Ω ±5% 1/4W	
" R92 thru SZ334 - R94	RD25S 270ΩJ	R: FXD CAR 270Ω ±5% 1/4W	

Parts No.	Stock No.	Description	
SZ334 - R95 thru " R97	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R98 thru " R102	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R103		Not assigned	
" R104	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R105		Not assigned	
" R106	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R107	RD25S 33ΩJ	R: FXD CAR 33Ω ±5% 1/4W	
" R108	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R109	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R110	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R111		Not assigned	
" R112	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R113	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" R114	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R115	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R116	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R117	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R118	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R119	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R120	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R121	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R122 thru " R128	RD25S 82ΩJ	R: FXD CAR 82Ω ±5% 1/4W	
" R129	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R130	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R131	RD25S 82ΩJ	R: FXD CAR 82Ω ±5% 1/4W	
" R132 thru " R136	TMR6-332	R: FXD COM 33kΩ	
" R137 thru SZ334 - R144	RD25S 680ΩJ	R: FXD CAR 680 ±5% 1/4W	

Parts No.	Stock No.	Description	
SZ334 - R145 thru " R152	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R153	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R154	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R155	CHR-2 50ΩJ	R: FXD CHIP 50Ω ±5% 2W	
" C156 thru " C159	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C160		Not assigned	
" C161		Not assigned	
" C162	221M1002-156M	C: FXD ELECT TANTAL 15μF ±20% 10V	
" C163	221M3502-106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C164	221M3502-106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C165	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C166	C52AF1H104Z	C: FXD CHIP 0.1μF +80, -20% 50V	
" C167	DM10C120K5	C: FXD DIPPED MICA 12pF ±10% 500V	
" C168	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C169	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C170	ECV1ZW20X31	C: VAR CER 20pF	
" C171	DM10D330J5	C: FXD DIPPED MICA 33pF ±5% 500V	
" C172	DM15D511J3	C: FXD DIPPED MICA 510pF ±5% 300V	
" C173	DM10D101J3	C: FXD DIPPED MICA 100pF ±5% 300V	
" C174	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C175	0.01UF 50WV	C: FXD CAR 0.01μF +80, -20% 50V	
" C176	DM15D102J3	C: FXD DIPPED MICA 1000pF ±5% 300V	
" C177	221M1002 156M	C: FXD ELECT TANTAL 15μF ±20% 10V	
" C178	111M1002 336M	C: FXD ELECT TANTAL 33μF ±20% 10V	
" C179 thru " C185	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C186	111M1002-336M	C: FXD ELECT TANTAL 33μF ±20% 10V	
" C187	221M1002-156M	C: FXD ELECT TANTAL 15μF ±20% 10V	
" C188 thru SZ334 - C190	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	

Parts No.	Stock No.	Description	
SZ334 - X191	XU-060	Crystal	※
" J196	1-163740-9	Connector	※
" C201	221M1002-336M	C: FXD ELECT TANTAL 33μF ±20% 10V	
" C202	0.001UF 50WV	C: FXD CER 0.001μF +80, -20% 50V	
" C203	111M1002-107M	C: FXD ELECT TANTAL 100μF ±20% 10V	
" C204	221M2502-336M	C: FXD ELECT TANTAL 33μF ±20% 25V	
" L211 thru SZ334 - L213	TPF0410-391K	L: FXD Coil 390μH	
	401-9630	Terminal	
	3-330808-9	Pin Socket	

Parts No.	Stock No.	Description	
SG175 - D1 thru " D8	TLR-313	Light Emitting Diode	
SG175 - J10	1-163680-9	Connector	※

Parts No.	Stock No.	Description	
SH212 - IC1	THD-412	IC: Hybride	※
" Q6	FJ901F	Transistor SI NPN	
" Q7	FJ901F	Transistor SI NPN	
" R11	THP007-6	6dB PAD	※
" R12	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R13	RD25S 5.6KΩJ	R: FXD CAR 5.6KΩ ±5% 1/4W	
" R14	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R15	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R16	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R17	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R18	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R19	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R20	RD50S 330ΩJ	R: FXD CAR 330Ω ±5% 1/2W	
" R21	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R22	RD25S 82ΩJ	R: FXD CAR 82Ω ±5% 1/4W	
" R23	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R24		Not assigned	
" R25	RD50S 100ΩJ	R: FXD CAR 100Ω ±5% 1/2W	
" R26	X6S 10KΩ	R: VAR WW 10kΩ	
" C31 thru " C34	C76AF1H474Z	C: FXD CHIP 0.47μF +80, -20% 50V	
" C35	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C36	BLM1H472NA	C: FXD BL 4700pF	
" C37 thru " C39	C76AF1H474Z	C: FXD CHIP 0.47μF +80, -20% 50V	
" C40	C52AF1H103Z	C: FXD CHIP 0.01μF +80, -20% 50V	
" C41	BLM1H472NA	C: FXD BL 4700pF	
" C42	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C43	C76AF1H474Z	C: FXD CHIP 0.47μF +80, -20% 50V	
" C44	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
SH212 - C45	C76AF1H474Z	C: FXD CHIP 0.47μF +80, -20% 50V	

Parts No.	Stock No.	Description	
SH212 - C46	221M2502-336M	C: FXD ELECT TANTAL 33μF ±20% 25V	
" C47	221M1002-336M	C: FXD ELECT TANTAL 33μF ±20% 10V	
" L51	L-0005	L: FXD Coil	※
" L52	L-0005	L: FXD Coil	※
" L53		L: FXD Coil	※
" L54		L: FXD Coil	※
" L55	TPF-0410-391K	L: FXD Coil 390μH	
SH212 - L56	TPF-0410-391K	L: FXD Coil 390μH	
	3-330808-9	Pin Socket	

Parts No.	Stock No.	Description	
PG117 - IC1	LM301A	IC: Operational Amplifier	
" IC2	LM308AH	IC: Operational Amplifier	
" IC3 thru " IC5	LM301A	IC: Operational Amplifier	
" IC6	LM308AH	IC: Operational Amplifier	
" Q11	AD842	FET Junction N-Channel	
" Q12	2SC1834	Transistor SI NPN	
" Q13	2SA1015	Transistor SI PNP	
" Q14	2SA1015	Transistor SI PNP	
" Q15 thru " Q18	2SC1834	Transistor SI NPN	
" Q19	AD842	FET Junction N-Channel	
" Q20	2SC1834	Transistor SI NPN	
" Q21	2SC1834	Transistor SI NPN	
" Q22	2SA1015	Transistor SI PNP	
" Q23	2SA1015	Transistor SI PNP	
" Q24	2SC1014	Transistor SI NPN	
" Q25 thru " Q28	2SA1015	Transistor SI PNP	
" Q29 thru " Q31	2SC1279S	Transistor SI NPN	
" Q32 thru " Q34	2SC1834	Transistor SI NPN	
" Q35	ITS30088B	FET Junction N-Channel	
" Q36	2SC1834	Transistor SI NPN	
" Q37	2SA1015	Transistor SI PNP	
" Q38	ITS30088B	FET Junction N-Channel	
" Q39	2SC1834	Transistor SI NPN	
" Q40	2SA1015	Transistor SI PNP	
" Q41	ITS30088B	FET Junction N-Channel	
" Q42	2SC1834	Transistor SI NPN	
PG177 - Q43	2SA1015	Transistor SI PNP	

Parts No.	Stock No.	Description	
PG177 - Q44	ITS30088B	FET Junction N-Channel	
" Q45	ITS30088B	FET Junction N-Channel	
" Q46	AD842	FET Junction N-Channel	
" Q47	2SC1834	Transistor SI NPN	
" Q48	AD842	FET Junction N-Channel	
" Q49	2SC1834	Transistor SI NPN	
" Q50	2SC1834	Transistor SI NPN	
" Q51	2SC1014	Transistor SI NPN	
" Q52	2SC1834	Transistor SI NPN	
" Q53	2SA1015	Transistor SI PNP	
" Q54	ITS30088B	FET Junction N-Channel	
" Q55	ITS30088B	FET Junction N-Channel	
" Q56	2SC1815GR	Transistor SI NPN	
" Q57	2SA1015	Transistor SI PNP	
" D66	1S953	Diode SI	
" D67	ZD-2C	Zener Diode	※
" D68	1S953	Diode SI	
" D69	ZD-2C	Zener Diode	※
" D70 thru " D72	1S953	Diode SI	
" D73	LD-1	Zener Diode	
" D74 thru " D77	1S953	Diode SI	
" R81	CRB 1/2FX 910KΩ	R: FXD Metal FLM 910kΩ ±1% 1/2W	
" R82	CRB 1/2FX 910KΩ	R: FXD Metal FLM 910kΩ ±1% 1/2W	
" R83	X6S 2KΩ	R: VAR WW 2kΩ	
" R84	RN65E 1.5KΩF	R: FXD Metal FLM 1.5kΩ ±1% 1/4W	
" R85	RN65E 7.7KΩD	R: FXD Metal FLM 7.7kΩ ±0.5% 1/4W	
" R86	X6S 2KΩ	R: VAR WW 2kΩ	
" R87 thru " R89	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
PG177 - R90	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PG177 - R91	CRB 1/4FX 10KΩJ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R92	CRB 1/4FX 3.9KΩJ	R: FXD Metal FLM 3.9kΩ ±1% 1/4W	
" R93	CRB 1/4FX 10KΩJ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R94	RF1/4N 1KΩSF	R: FXD Metal FLM 1kΩ ±1% 1/4W	
" R95	RF1/4N 1KΩSF	R: FXD Metal FLM 1kΩ ±1% 1/4W	
" R96	RF1/4N 1.5KΩSF	R: FXD Metal FLM 1.5kΩ ±1% 1/4W	
" R97	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R98 thru " R101	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R102	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R103 thru " R106	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R107	RN65E 500ΩF	R: FXD Metal FLM 500Ω ±1% 1/4W	
" R108	CRB 1/4FX 3.57KΩ	R: FXD Metal FLM 3.57kΩ ±1% 1/4W	
" R109		Not assigned	
" R110	X6T 1KΩ	R: VAR WW 1kΩ	
" R111	CRB 1/4FX 6.2KΩ	R: FXD Metal FLM 6.2kΩ ±1% 1/4W	
" R112	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R113	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R114	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R115	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R116	CRB 1/4FX 3.9KΩ	R: FXD Metal FLM 3.9kΩ ±1% 1/4W	
" R117	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R118	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R119	CRB 1/4FX 3.9KΩ	R: FXD Metal FLM 3.9kΩ ±1% 1/4W	
" R120	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R121	X6S 1KΩ	R: VAR WW 1kΩ	
" R122	CRB 1/4FX 5KΩ	R: FXD Metal FLM 5kΩ ±1% 1/4W	
" R123	RN65E 500ΩF	R: FXD Metal FLM 500Ω ±1% 1/4W	
" R124	RN65E 1.66KΩF	R: FXD Metal FLM 1.66kΩ ±1% 1/4W	
" R125	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R126	CRB 1/4FX 2.7KΩ	R: FXD Metal FLM 2.7kΩ ±1% 1/4W	
PG177 - R127	CRB 1/4FX 18KΩ	R: FXD Metal FLM 18kΩ ±1% 1/4W	

Parts No.	Stock No.	Description	
PG177 - R128	X6S 5KΩ	R: VAR WW 5kΩ	
" R129	CRB 1/4FX 3.3KΩ	R: FXD Metal FLM 3.3kΩ ±1% 1/4W	
" R130	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R131 thru " R133	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R134	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R135 thru " R138	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R139	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R140	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R141	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R142 thru " R144	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R145	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R146	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R147	CRB 1/4FX 2.49KΩ	R: FXD Metal FLM 2.49kΩ ±1% 1/4W	
" R148	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R149	CRB 1/4FX 1KΩ	R: FXD Metal FLM 1kΩ ±1% 1/4W	
" R150	CRB 1/4FX 110Ω	R: FXD Metal FLM 110Ω ±1% 1/4W	
" R151 thru " R153	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R154	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R155 thru " R158	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R159	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R160 thru " R162	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R163	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R164	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R165	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R166 thru PG177 - R168	RD25S 820KΩJ	R: FXD CAR 820kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PG177 - R169	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R170	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R171	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R172	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R173	CRB 1/4FX 3.9KΩ	R: FXD Metal FLM 3.9kΩ ±1% 1/4W	
" R174	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R175	X6S 500Ω	R: VAR 500Ω	
" R176	RF1/4N 9.8KΩRF	R: FXD Metal FLM 9.8kΩ ±1% 1/4W	
" R177	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R178	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R179	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R180	CRB 1/4FX 10KΩJ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R181	CRB 1/4FX 3.9KΩ	R: FXD Metal FLM 3.9kΩ ±1% 1/4W	
" R182	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R183	RH10-55ΩJ	R: FXD WW 55Ω ±5% 10W	
" R184	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R185	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R186	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R187	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R188	RD25S 820KΩJ	R: FXD CAR 820kΩ ±5% 1/4W	
" R189	RD25S 820KΩJ	R: FXD CAR 820kΩ ±5% 1/4W	
" R190	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R191	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R192	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R193	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R194	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R195	CRB 1/4FX 220Ω	R: FXD Metal FLM 220Ω ±1% 1/4W	
" R196	X6T 50Ω	R: VAR WW 50Ω	
" R197	CRB 1/2FX 270KΩ	R: FXD Metal FLM 270kΩ ±1% 1/2W	
" R198		Not assigned	
" R199	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R200	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R201	RF1/4N 9.8KΩRF	R: FXD Metal FLM 9.8kΩ ±1% 1/4W	
PG177 - C211	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	

Parts No.	Stock No.	Description	
PG177 - C212	25T100	C: FXD ELECT 100μF 25V	
" C213	25T100	C: FXD ELECT 100μF 25V	
" C214	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C215	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C216	25T100	C: FXD ELECT 100μF 25V	
" C217	25T100	C: FXD ELECT 100μF 25V	
" C218 thru " C220	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C221	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C222 thru " C224	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C225	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C226	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C227	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C228	111M1002-227M	C: FXD ELECT TANTAL 220μF ±20% 10V	
" C229	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C230 thru " C232	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C233	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C234 thru " C236	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C237	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C238 thru " C240	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C241	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C242	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C243	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C244	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C245	25T100	C: FXD ELECT 100μF 25V	
" C246	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
PG177 - L251	CSL0609-181K	L: FXD Coil 180uH	

Parts No.	Stock No.	Description	
PG177 - L252	CSL0609-181K	L: FXD Coil 180μH	※
PG177 - J260	PCN6-5PA-2.5DS	Connector	
	401-9630	Terminal	

Parts No.	Stock No.	Description	
PF119 - IC1 thru " IC4	LM301A	IC: Operational Amplifier	
" IC5	LM311	IC: Voltage Comparator	
" IC6	SN74LS73	IC: Dual J-K Master-Slave Flip-Flop Low Power	
" IC7	SN74LS123	IC: Dual Retriggerable Monostable Multivibrator with Clear Low Power	
" IC8	SN74LS123	IC: Dual Retriggerable Monostable Multivibrator with Clear Low Power	
" IC9	SN74LS04	IC: Hex Inverter Low Power	
" IC10	SN74LS03	IC: Quadruple 2-Input NAND Gate with Open Collector Output Low Power	
" IC11	SN7400	IC: Quadruple 2-Input NAND Gate	
" IC12	SN74LS00	IC: Quadruple 2-Input NAND Gate Low Power	
" IC13	SN74LS04	IC: Hex Inverter Low Power	
" IC14	LM310	IC: Voltage Follower	
" IC15	SN74LS123	IC: Dual Retriggerable Monostable Multivibrator with Clear Low Power	
" IC16	SN74LS00	IC: Quadruple 2-Input NAND Gate Low Power	
" Q21	AD820	Transistor	
" Q22 thru " Q27	2SC1834	Transistor SI NPN	
" Q28	2N2609	Transistor SI PNP	
" Q29	2N4393	Transistor SI PNP	
" Q30	2SC1834	Transistor SI NPN	
" Q31	2SA1015	Transistor SI PNP	
" Q32	2N4393	Transistor SI PNP	
" Q33	2N2609	Transistor SI PNP	
" Q34 thru PF119 - Q38	2SC1834	Transistor SI NPN	

Parts No.	Stock No.	Description	
PF119 - Q39	2N4393	Transistor SI PNP	
" Q40	2N4393	Transistor SI PNP	
" Q41	2SC1834	Transistor SI NPN	
" Q42	2SA1015	Transistor SI PNP	
" Q43	2SC1834	Transistor SI NPN	
" Q44	2SA1015	Transistor SI PNP	
" Q45	2SC1834	Transistor SI NPN	
" Q46	2N4393	Transistor SI PNP	
" Q47 thru " Q50	2SC1834	Transistor SI NPN	
" D56	1S953	Diode SI	
" D57 thru " D59		Not assigned	
" D60	1S953	Diode SI	
" D61	LD-1	Diode SI	
" D62 thru " D69	1S953	Diode SI	
" R71	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R72	X6S 1KΩJ	R: VAR 1kΩ	
" R73	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R74	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R75	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R76	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R77	CRB 1/4FX 3.3KΩ	R: FXD Metal FLM 3.3kΩ ±1% 1/4W	
" R78	X6S 1KΩ	R: VAR WW 1kΩ	
" R79	CRB 1/4FX 100KΩ	R: FXD Metal FLM 100kΩ ±1% 1/4W	
" R80	CRB 1/4FX 250Ω	R: FXD Metal FLM 250Ω ±1% 1/4W	
" R81	X6S 50Ω	R: VAR WW 50Ω	
" R82	CRB 1/4FX 100KΩ	R: FXD Metal FLM 100kΩ ±1% 1/4W	
" R83	CRB 1/4FX 57.6KΩ	R: FXD Metal FLM 57.6kΩ ±1% 1/4W	
" R84	CRB 1/4FX 40.2KΩ	R: FXD Metal FLM 40.2kΩ ±1% 1/4W	
PF119 - R85	CRB 1/4FX 20KΩ	R: FXD Metal FLM 20kΩ ±1% 1/4W	

PF119 RAMP GENERATOR

Parts No.	Stock No.	Description	
PF119 - R86	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R87 thru " R90	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R91	RD25S 220KΩJ	R: FXD CAR 220kΩ ±5% 1/4W	
" R92	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R93	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R94	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R95 thru " R97	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R98	RD25S 220KΩJ	R: FXD CAR 220kΩ ±5% 1/4W	
" R99	CRB 1/4FX 3.24KΩ	R: FXD Metal FLM 3.24kΩ ±1% 1/4W	
" R100	CRB 1/4FX 1.21KΩ	R: FXD Metal FLM 1.21kΩ ±1% 1/4W	
" R101	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R102	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R103	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R104	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R105	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R106	RD25S 5.1KΩJ	R: FXD CAR 5.1kΩ ±5% 1/4W	
" R107	RD25S 220KΩJ	R: FXD CAR 220kΩ ±5% 1/4W	
" R108	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R109	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R110	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" R111	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R112	RD25S 220KΩJ	R: FXD CAR 220kΩ ±5% 1/4W	
" R113	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R114	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R115	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R116	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R117	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R118	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R119	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
PF119 - R120	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PF119 - R121 thru " R123	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R124	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R125	RD25S 680KΩJ	R: FXD CAR 680kΩ ±5% 1/4W	
" R126	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R127	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R128 thru " R130	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R131	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R132	RD25S 680KΩJ	R: FXD CAR 680kΩ ±5% 1/4W	
" R133 thru " R135	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R136	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R137	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R138	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R139	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R140	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R141	RD25S 1MΩJ	R: FXD CAR 1MΩ ±5% 1/4W	
" R142	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R143	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R144	RJ6S 503	R: VAR CERMET 50kΩ	
" R145	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R146	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R147	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R148	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R149	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R150	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R151	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R152	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R153	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R154	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R155	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
PF119 - R156	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PF119 - R157	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R158	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R159	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R160	RD25S 1MΩJ	R: FXD CAR 1MΩ ±5% 1/4W	
" R161	CRB 1/4FX 33KΩ	R: FXD Metal FLM 33kΩ ±1% 1/4W	
" R162	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R163	RD25S 56KΩJ	R: FXD CAR 56kΩ ±5% 1/4W	
" C166 thru " C171	SL25TH10	C: FXD ELECT 10μF 25V	
" C172	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C173	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C174	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C175	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C176	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C177	431M-2003-105K	C: FXD Mylar 1μF ±10% 200V	
" C178	501M-5002-102K	C: FXD Mylar 0.001μF ±10% 500V	
" C179	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C180	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C181	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C182	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C183	431M-2003-104K	C: FXD Mylar 0.1μF ±10% 200V	
" C184	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C185	33PF 50WV	C: FXD CER 33pF ±10% 50V	
" C186	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C187	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C188	12PF 50WV	C: FXD CER 12pF ±10% 50V	
" C189	12PF 50WV	C: FXD CER 12pF ±10% 50V	
" C190		Not assigned	
" C191 thru " C193	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C194	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C195	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
PF119 - C196	221M3502 155M	C: FXD ELECT TANTAL 1.5μF ±20% 35V	

Parts No.	Stock No.	Description	
PF119 - C197	200PF 50WV	C: FXD CER 200pF ±10% 50V	
" C198	221M3502 335M	C: FXD ELECT TANTAL 3.3μF ±20% 35V	
" C199 thru " C201	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C202	221M3502-106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C203	221M3502-106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C204	100PF 50WV	C: FXD CER 100pF ±10% 50V	
" C205	100PF 50WV	C: FXD CER 100pF ±10% 50V	
" L206 thru " L210	CSL0609-181K	L: FXD Coil 180μH	
" R211	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R212	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R213	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R214	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
	401-9630	Terminal	
" C216	221M1002-336M	C: FXD ELECT TANTAL 33μF ±20% 10V	
" C217	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C218	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
PF119 - C219	25T10	C: FXD ELECT 10μF 25V	
	401-8079	Board Handle	

Parts No.	Stock No.	Description	
PK022 - IC1	LM324	IC: Quadruple Operational Amplifier	
" IC2	LM324	IC: Quadruple Operational Amplifier	
" Q6 thru " Q18	2SC1834	Transistor SI NPN	
" D26 thru " D61	1S2222	Diode SI	
" R71	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R72	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R73	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R74	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R75	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R76	X6T 50Ω	R: VAR WW 50Ω	
" R77	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R78	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R79	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R80	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R81	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R82	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R83	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R84	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R85	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R86	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R87	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R88	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R89	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R90	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R91 thru " R93	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R94	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
PK022 - R95	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PK022 - R96	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R97	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R98	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R99	X6T 50Ω	R: VAR WW 50Ω	
" R100	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R101	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R102	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R103	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R104	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R105	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R106	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R107	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R108	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R109	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R110 thru " R112	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R113	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R114 thru " R116	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R117	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R118	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R119	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R120	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R121	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R122	X6S 50Ω	R: VAR WW 50Ω	
" R123	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R124	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R125	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R126	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R127	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R128	RD25S 82ΩJ	R: FXD CAR 82Ω ±5% 1/4W	
" R129	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
PK022 - R130	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	

Parts No.	Stock No.	Description	
PK022 - R131	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R132	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R133	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R134	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R135	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R136	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R137	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R138	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R139 thru " R141	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R142	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R143 thru " R145	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R146	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R147	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R148	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R149	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R150	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R151	X6T 50Ω	R: VAR WW 50Ω	
" R152	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R153	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R154	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R155	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R156	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R157	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R158	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R159	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R160	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R161 thru " R163	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R164	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R165	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
PK011 - R166	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PK022 - R167	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R168	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R169	X-6T 50Ω	R: VAR WW 50Ω	
" R170	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R171	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R172	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R173	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R174	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R175	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R176	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R177	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R178	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R179 thru " R181	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R182	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R183	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R184	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R185	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R186	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R187	X-6T 50Ω	R: VAR WW 50Ω	
" R188	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R189	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R190	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R191	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R192	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R193	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R194	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R195	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R196	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R197	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R198	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R199	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R200	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
PK022 - R201	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PK022 - R202	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R203	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R204	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R205	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R206	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R207	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R208	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R209	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R210	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R211	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R212	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R213	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R214 thru " R219	RD25S 330KΩJ	R: FXD CAR 330kΩ ±5% 1/4W	
" R220	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R221	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" C231 thru " C233	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C234	DM10D111J3	C: FXD DIPPED MICA 110pF ±5% 300V	
" C235	DM10C120K5	C: FXD DIPPED MICA 12pF ±10% 500V	
" C236	DM10D181J3	C: FXD DIPPED MICA 180pF ±5% 300V	
" C237	DM10C120K5	C: FXD DIPPED MICA 12pF ±10% 500V	
" C238	DM10D111J3	C: FXD DIPPED MICA 110pF ±5% 300V	
" C239	ECV-1ZW20X31	C: VAR CER 20pF	
" C240	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C241	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C242	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C243	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C244 thru " C253	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C254	DM10D680J3	C: FXD DIPPED MICA 68pF ±5% 300V	
" C255	DM10D121J3	C: FXD DIPPED MICA 120pF ±5% 300V	
PK022 - C256	ECV-1ZW-70X31	C: VAR CER 70pF	

Parts No.	Stock No.	Description	
PK022 - C257	DM10C200K5	C: FXD DIPPED MICA 20pF ±10% 500V	
" C258	DM10D121J3	C: FXD DIPPED MICA 120pF ±5% 300V	
" C259	ECV-1ZW70X31	C: VAR CER 70pF	
" C260	DM10C150K5	C: FXD DIPPED MICA 15pF ±10% 500V	
" C261	DM10D121J3	C: FXD DIPPED MICA 120pF ±5% 300V	
" C262	ECV-1ZW70X31	C: VAR CER 70pF	
" C263	DM10C150K5	C: FXD DIPPED MICA 15pF ±10% 500V	
" C264	DM10D121J3	C: FXD DIPPED MICA 120pF ±5% 300V	
" C265	ECV-1ZW70X31	C: VAR CER 70pF	
" C266	DM10C200K5	C: FXD DIPPED MICA 20pF ±10% 500V	
" C267	DM10D121J3	C: FXD DIPPED MICA 120pF ±5% 300V	
" C268	ECV-1ZW70X31	C: VAR CER 70pF	
" C269	DM10D680J3	C: FXD DIPPED MICA 68pF ±5% 300V	
" C270	ECV-1ZW20X31	C: VAR CER 20pF	
" C271	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C272	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C273	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C274	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C275 thru " C290	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C291 thru " C293	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C294 thru " C303	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C304		Not assigned	
" C305		Not assigned	
" C306	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C307	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C308	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C309	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C310 thru " C315	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
PK022 - C316	DM10C100K5	C: FXD DIPPED MICA 10pF ±10% 500V	

Parts No.	Stock No.	Description	
PK022 - C317	DM10C100K5	C: FXD DIPPED MICA 10pF ±10% 500V	
" C318	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C319	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C320	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C321	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C322 thru " C327	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C328	DM10C100K5	C: FXD DIPPED MICA 10pF ±10% 500V	
" C329	DM10C100K5	C: FXD DIPPED MICA 10pF ±10% 500V	
" C330	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C331	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C332	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C333	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C334 thru " C357	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C358	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C359	111M2502 106M	C: FXD ELECT TANTAL 10μF ±20% 25V	
" C360	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C361	111M2502 106M	C: FXD ELECT TANTAL 10μF ±20% 25V	
" L371	L07A-47	L: FXD Coil	※
" L372	L10A-1	L: FXD Coil	※
" L373	L07A-46	L: FXD Coil	※
" L374	L10A-1	L: FXD Coil	※
" L375	L07A-47	L: FXD Coil	※
" L376	TPF0410L-120K	L: FXD Coil 12μH	
" L377 thru " L381	TPF0410L-1R2K	L: FXD Coil 1.2μH	
" L382	TPF0410L-330K	L: FXD Coil 33μH	
" L383	TPF0410L-330K	L: FXD Coil 33μH	
" L384	TPF0410L-120K	L: FXD Coil 12μH	
PK022 - XF391	YF10.7AR	Crystal Filter	※

Parts No.	Stock No.	Description	
PK002 - XF392	YF10.7AQ	Crystal Filter	※
" XF393	YF10.7AP	Crystal Filter	※
" J401	UM-LR-PC	Connector	※
PK022 - J402	UM-LR-PC	Connector	※
	401-9630	Terminal	

Parts No.	Stock No.	Description	
PK026 - IC1	LM324	IC: Quadruple Operational Amplifier	
" IC2	LM324	IC: Quadruple Operational Amplifier	
" Q6	2SC1834	Transistor SI NPN	
" Q7	2SA1015	Transistor SI PNP	
" Q8	2SA1015	Transistor SI PNP	
" Q9 thru " Q11	2SC1834	Transistor SI NPN	
" Q12	2SA1015	Transistor SI PNP	
" Q13	2SA1015	Transistor SI PNP	
" Q14 thru " Q16	2SC1834	Transistor SI NPN	
" Q17	2SA1015	Transistor SI PNP	
" Q18	2SC1834	Transistor SI NPN	
" Q19	2SA1015	Transistor SI PNP	
" Q20	2SC1834	Transistor SI NPN	
" Q21	2SC1834	Transistor SI NPN	
" Q22	2SA1015	Transistor SI PNP	
" Q23	2SA1015	Transistor SI PNP	
" Q24 thru " Q26	2SC1834	Transistor SI NPN	
" D31	5082-3379	Diode SI	
" D32 thru " D34	1S953	Diode SI	
" D35	5082-3379	Diode SI	
" D36 thru " D40	1S2222	Diode SI	
" D41	1S953	Diode SI	
PK026 - D42	1S953	Diode SI	

Parts No.	Stock No.	Description	
PK026 - D43 thru " D46	1S2222	Diode SI	
" D47	1S953	Diode SI	
" D48 thru " D57	1S2222	Diode SI	
" D58 thru " D65	1S953	Diode SI	
" R71	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R72	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R73	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R74	X6S 2KΩ	R: VAR WW 2kΩ	
" R75	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R76	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R77	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R78	RD25S 180ΩJ	R: FXD CAR 180Ω ±5% 1/4W	
" R79	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R80	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R81	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R82	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R83	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R84	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R85	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R86	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R87	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R88	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R89	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R90	X-6S 10KΩ	R: VAR WW 10kΩ	
" R91	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R92	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R93	X-6S 10KΩ	R: VAR WW 10kΩ	
" R94	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
PK026 - R95	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	

Parts No.	Stock No.	Description	
PK026 - R96	RD25S 56ΩJ	R: FXD CAR 56Ω ±5% 1/4W	
" R97	RD25S 27KΩJ	R: FXD CAR 27kΩ ±5% 1/4W	
" R98	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R99	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R100	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R101	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R102	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R103	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R104	RD25S 3.9KΩJ	R: FXD CAR 3.9kΩ ±5% 1/4W	
" R105	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R106	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R107 thru " R110	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R111	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R112	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R113	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R114	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R115	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R116	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R117	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R118	RD25S 33ΩJ	R: FXD CAR 33Ω ±5% 1/4W	
" R119	RD25S 33ΩJ	R: FXD CAR 33Ω ±5% 1/4W	
" R120	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R121	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R122	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R123	X-6S 200ΩJ	R: VAR WW 200Ω	
" R124	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R125	X-6S 50Ω	R: VAR WW 50Ω	
" R126	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R127	X-6S 20Ω	R: VAR WW 20Ω	
" R128	RD25S 22ΩJ	R: FXD CAR 22Ω ±5% 1/4W	
" R129	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
PK026 - R130	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PK026 - R131	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R132	RD25S 68ΩJ	R: FXD CAR 68Ω ±5% 1/4W	
" R133	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R134	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R135	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R136	RD25S 220ΩJ	R: FXD CAP 220Ω ±5% 1/4W	
" R137	X-6S 50Ω	R: VAR WW 50Ω	
" R138	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R139	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R140	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R141	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" R142	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R143	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" R144	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R145	RD25S 270ΩJ	R: FXD CAR 270Ω ±5% 1/4W	
" R146	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R147 thru " R149	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R150	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R151	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R152	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
" R153 thru " R158	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R159	RD25S 27ΩJ	R: FXD CAR 27Ω ±5% 1/4W	
" R160	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R161	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R162	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R163	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R164	RD25S 82ΩJ	R: FXD CAR 82Ω ±5% 1/4W	
" R165	X-6S 100Ω	R: VAR WW 100Ω	
" R166	RD25S 68ΩJ	R: FXD CAR 68Ω ±5% 1/4W	
" R167	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
PK026 - R168	RD25S 12KΩJ	R: FXD CAP 12kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PK026 - R169	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R170 thru " R181	RD25S 220KΩJ	R: FXD CAR 220kΩ ±5% 1/4W	
" R182	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R183	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R184	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R185	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R186	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R187	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R188	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R189	RD25S 150ΩJ	R: FXD CAR 150Ω ±5% 1/4W	
" R190	RD25S 390ΩJ	R: FXD CAR 390Ω ±5% 1/4W	
" C191 thru " C193	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C194	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C195	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C196	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C197	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C198 thru " C200	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C201 thru " C204	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C205	111M2502 155M	C: FXD ELECT TANTAL 1.5μF ±20% 25V	
" C206 thru " C208	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C209	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C210 thru " C222	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C223	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C224 thru PK026 - C229	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	

Parts No.	Stock No.	Description	
PK026 - C230	DM10D300J5	C: FXD DIPPED MICA 30pF ±5% 500V	
" C231	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C232 thru " C234	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C235	150PF 50WV	C: FXD CER 150pF ±10% 50V	
" C236 thru " C243	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C244	ECV-1ZW20X31	C: VAR CER 20pF	
" C245 thru " C250	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C251	ECV-1ZW10X31	C: VAR CER 10pF	
" C252	ECV-1ZW30X31	C: VAR CER 30pF	
" C253	DM10D101J3	C:- FXD DIPPED MICA 100pF ±5% 300V	
" C254	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C255 thru " C258	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C259	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C260	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C261	111M2502 106M	C: FXD ELECT TANTAL 10μF ±20% 25V	
" C262	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C263	111M2502 106M	C: FXD ELECT TANTAL 10μF ±20% 25V	
" C264	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C265	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C266	100PF 50WV(A)J	C: FXD Styrol 100pF ±5% 50V	
" C267	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C268	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C269	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C270	10PF 50WV	C: FXD CER 10pF ±10% 50V	
" L271 thru " L277	TPF0410L-330K	L: FXD Coil 33μH	
PK026 - L278	TPF0410L-120K	L: FXD Coil 12μH	

Parts No.	Stock No.	Description	
PK026 - L279	TPF0410L-120K	L: FXD Coil 12μH	
" L280	TPF0410L-330K	L: FXD Coil 33μH	
" L281	L10D-1	L: FXD Coil	※
" L282	TPF0410L-330K	L: FXD Coil 33μH	
" L283	TPF0410L-330K	L: FXD Coil 33μH	
" X291	XU-086	Crystal	※
" J296	UM-LR-PC	Connector	※
" J297	UM-LR-PC	Connector	※
" TH301	11D27	Thermistor 10Ω	
PK026 - TH302	31D26	Thermistor 1kΩ	
	401-9630	Terminal	

Parts No.	Stock No.	Description	
PH190 - IC1	LM301A	IC: Operational Amplifier	
" Q11 thru Q33	2SC1834	Transistor SI NPN	
" Q34	2SC1730	Transistor SI NPN	
" Q35	2SC1815GR	Transistor SI NPN	
" Q36	2SA1015	Transistor SI PNP	
" Q37	2SC1815GR	Transistor SI NPN	
" Q38	2SA711	Transistor SI PNP	
" Q39	μPA38	Dual Transistor SI NPN	
" Q40	2SC1834	Transistor SI NPN	
" Q41	2SA1015	Transistor SI PNP	
" Q42	ITS3948	FET Junction N-Channel	
" Q43	2SA1015	Transistor SI PNP	
" Q44	2SA1015	Transistor SI PNP	
" Q45 thru " Q57	2SC1834	Transistor SI NPN	
" Q58	2N4393	FET Junction N-Channel	
" Q59	ITS3008B	FET Junction N-Channel	
" Q60	2SC1815GR	Transistor SI NPN	
" Q61	2SC1834	Transistor SI NPN	
" Q62	2SC1834	Transistor SI NPN	
" Q63	2SC696	Transistor SI NPN	
" Q64	2SC1834	Transistor SI NPN	
" Q65	2SC1834	Transistor SI NPN	
" D71 thru " D92	1SS43	Diode SI	
" D93 thru " D96	1S953	Diode SI	
" D97	1SS43	Diode SI	
" D98 thru PH190 - D105	1S953	Diode SI	

Parts No.	Stock No.	Description	
PH190 - D106		Not assigned	
" D107		Not assigned	
" D108	1S953	Diode SI	
" D109	WZ-056	Zener Diode	
" R111	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R112	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R113	CRB 1/4FX 820ΩJ	R: FXD Metal FLM 820Ω ±1% 1/4W	
" R114	CRB 1/4FX 750ΩJ	R: FXD Metal FLM 750Ω ±1% 1/4W	
" R115	CRB 1/4FX 5.6KΩJ	R: FXD Metal FLM 5.6kΩ ±1% 1/4W	
" R116	CRB 1/4FX 5.6KΩJ	R: FXD Metal FLM 5.6kΩ ±1% 1/4W	
" R117	RD25S 18KΩJ	R: FXD CAR 18kΩ ±5% 1/4W	
" R118		Not assigned	
" R119	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R120	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R121	RD25S 2.7KΩJ	R: FXD CAR 2.7kΩ ±5% 1/4W	
" R122	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R123	CRB 1/4FX 330ΩJ	R: FXD Metal FLM 330Ω ±1% 1/4W	
" R124	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R125	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R126	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R127	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R128	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R129	CRB 1/4FX 10KΩ	R: FXD Metal FLM 10kΩ ±1% 1/4W	
" R130	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R131	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R132	RD25S 1.8KΩJ	R: FXD CAR 1.8kΩ ±5% 1/4W	
" R133	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R134	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R135	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R136	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R137	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R138	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R139	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
PH190 - R140	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PH190 - R141	RD25S 3.8KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R142	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R143	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R144	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R145	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R146	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R147	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R148	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R149	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R150	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R151	RD25S 6.8KΩJ	R: FXD CAR 6.8KΩ ±5% 1/4W	
" R152	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R153	CEB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R154	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R155	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R156	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R157	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R158	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R159	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R160	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R161	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R162	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R163	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R164	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R165	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R166	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R167	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R168	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R169	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R170	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R171	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R172	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R173	RD25S 51ΩJ	R: FXD CAR 51Ω ±5% 1/4W	
PH190 - R174	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PH190 - R175	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R176	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R177	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R178	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R179	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R180	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R181	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R182	RD25S 82KΩJ	R: FXD CAR 82kΩ ±5% 1/4W	
" R183	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R184	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R185	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R186	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R187	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R188	CRB 1/4FX 12KΩ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R189	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R190	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R191	X6T 500Ω	R: VAR WW 500Ω	
" R192	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R193	CRB 1/4FX 300Ω	R: FXD Metal FLM 300Ω ±1% 1/4W	
" R194	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R195	RD25S 39ΩJ	R: FXD CAR 39Ω ±5% 1/4W	
" R196	CRB 1/4FX 12KΩJ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R197	CRB 1/4FX 12KΩJ	R: FXD Metal FLM 12kΩ ±1% 1/4W	
" R198	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R199	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R200	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R201	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R202	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R203	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R204	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R205	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R206	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R207	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
PH190 R208	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PH190 - R209	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R210	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R211	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R212	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R213	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R214	RD25S 1.8KΩJ	R: FXD CAR 1.8kΩ ±5% 1/4W	
" R215	RD25S 2.7KΩJ	R: FXD CAR 2.7kΩ ±5% 1.4W	
" R216	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R217	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R218	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R219	RD25S 2.7KΩJ	R: FXD CAR 2.7kΩ ±5% 1/4W	
" R220	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R221	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R222	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R223	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R224	RF1/4N 330ΩFS	R: FXD Metal FLM 330Ω ±1% 1/4W	
" R225	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R226	RD25S 560ΩJ	R: FXD CAR 560Ω ±5% 1/4W	
" R227	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R228	RF1/4N 1KΩFS	R: FXD Metal FLM 1kΩ ±1% 1/4W	
" R229	RF1/4N 1KΩFS	R: FXD Metal FLM 1kΩ ±1% 1/4W	
" R230	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R231	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R232	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R233	RD25S 270ΩJ	R: FXD CAR 270Ω ±5% 1/4W	
" R234	RD25S 56KΩJ	R: FXD CAR 56kΩ ±5% 1/4W	
" R235	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R236	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R237	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R238	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R239	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R240	X6T 10KΩJ	R: VAR WW 10kΩ	
" R241	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
PH190 - R242	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PH190 - R243	X6T 10KΩ	R: VAR WW 10kΩ	
" R244	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R245	RD25S 18KΩJ	R: FXD CAR 18kΩ ±5% 1/4W	
" R246	X6T 20KΩ	R: VAR WW 20kΩ	
" R247	RD25S 2.7KΩJ	R: FXD CAR 2.7kΩ ±5% 1/4W	
" R248	X6T 10KΩ	R: VAR WW 10kΩ	
" R249 thru " R251		Not assigned	
" R252	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R253	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R254	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R255	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R256	RD25S 4.7KΩ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R257	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R258	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R259	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R260	RF1/4N 5.6KΩFS	R: FXD Metal FLM 5.6kΩ ±1% 1/4W	
" R261	X6T 5KΩ	R: VAR WW 5kΩ	
" R262	RF1/4 1KΩFS	R: FXD Metal FLM 1kΩ ±1% 1/4W	
" R263	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R264	X6T 2KΩ	R: VAR WW 2kΩ	
" R265	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" R266	RD25S 220JΩ	R: FXD CAR 220Ω ±5% 1/4W	
" R267 thru " R273	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R274	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" R275	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R276	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R277	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R278	RD25S 470KΩJ	R: FXD CAR 470kΩ ±5% 1/4W	
" R279	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R280	RD25S 27ΩJ	R: FXD CAR 27Ω ±5% 1/4W	
PH190 - R281	RD25S 68KΩJ	R: FXD CAR 68kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
PH190 - R282 thru " R286	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	
" R287 thru R290	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R291	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R292	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R293	RD25S 33ΩJ	R: FXD CAR 33Ω ±5% 1/4W	
" R294	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R295	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R296	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R297	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R298	X6T 2KΩJ	R: VAR WW 2kΩ	
R299	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R300 thru " R315	RD25S 10ΩJ	R: FXD CAR 10Ω ±5% 1/4W	
" R316	RD25S 22ΩJ	R: FXD CAR 22Ω ±5% 1/4W	
" C321 thru " C326	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C327	10PF 50WV	C: FXD CER 10pF ±10% 50V	
" C328	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C329	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C330	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 50V	
" C331	10PF 50WV	C: FXD CER 10pF ±10% 50V	
" C332 thru " C336	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C337	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C338	10PF 50WV	C: FXD CER 10pF ±10% 50V	
" C339 thru " C341	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C342	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
PH190 - C343	10PF 50WV	C: FXD CER 10pF ±10% 50V	

Parts No.	Stock No.	Description	
PH190 - C344 thru " C347	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C348	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C349	10PF 50WV	C: FXD CER 10pF ±10% 50V	
" C350 thru " C353	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C354	221M3502 106M	C: FXD ELECT TANTAL 10μ ±20% 35V	
" C355	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C356	10PF 50WV	C: FXD CER 10pF ±10% 50V	
" C357 thru " C359	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C360	10PF 50WV	C: FXD CER 10pF ±10% 50V	
" C361 thru " C367	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C368	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C369	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C370 thru " C374	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C375	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C376	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C377	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C378 thru " C380	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C381 thru " C383	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C384 thru " C390	0.022UF 25WV	C: FXD CER 0.022μF +80, -20% 25V	
" C391	DM10C030D5	C: FXD DIPPED MICA 3pF ±0.5% 500V	
" C392	DM10C100K5	C: FXD DIPPED MICA 10pF ±10% 500V	
" C393	DM10D220J5	C: FXD DIPPED MICA 22pF ±5% 500V	
" C394	DM10C030D5	C: FXD DIPPED MICA 3pF ±0.5% 500V	
PH190 - C395	DM10C010D5	C: FXD DIPPED MICA 1pF ±0.5% 500V	

Parts No.	Stock No.	Description	
PH190 - C396 thru " C398	0.022UF 50WV	C: FXD DIPPED MICA 0.022μF +80, -20% 50V	
" C399	DM10D620J3	C: FXD DIPPED MICA 62pF ±5% 300V	
" C400	ECV-1ZW20X31	C: VAR CER 20pF	
" C401 thru " C409	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C410	DM10D390J5	C: FXD DIPPED MICA 39pF ±0.5% 500V	
" C411	DM10D220J5	C: FXD DIPPED MICA 22pF ±5% 500V	
" C412	DM10D820J3	C: FXD DIPPED MICA 82pF ±5% 300V	
" C413	DM10C100K5	C: FXD DIPPED MICA 10pF ±10% 500V	
" C414	DM10D101J3	C: FXD DIPPED MICA 100pF ±5% 300V	
" C415	DM10C030D5	C: FXD DIPPED MICA 3pF ±0.5% 500V	
" C416	DM10D510J3	C: FXD DIPPED MICA 51pF ±5% 300V	
" C417 thru " C420	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C421	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C422	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C423	3PF 50WV	C: FXD CER 3pF ±10% 50V	
" C424	0.022UF 50WV	C: FXD CER 0.022μF ±80, -20% 50V	
" C425	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C426	0.001UF 50WV	C: FXD CER 0.001μF +80, -20% 50V	
" C427	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C428	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C429 thru " C434	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C435	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C436	25VBSN10	C: FXD ELECT 10μF 25V	
" C437	221M3502-106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C438	25VBSN10	C: FXD ELECT 10μF 25V	
" C439	221M3502-106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C440	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
PH290 - C441	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	

Parts No.	Stock No.	Description	
PH190 - C442	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C443	0.022UF 50WV	C: FXD CER 0.022μF +80, -20% 50V	
" C444	DM10D181J3	C: FXD DIPPED MICA 180pF ±5% 300V	
" C445	DM15D471J3	C: FXD DIPPED MICA 470pF ±5% 300V	
" C446	501N5002 472-K	C: FXD Polyester FLM 0.0047μF ±10% 50V	
" C447	501N5002 473-K	C: FXD Polyester FLM 0.047μF ±10% 50V	
" C448	221M3502 474M	C: FXD ELECT TANTAL 0.47μF ±20% 35V	
" C449	221M3502 105M	C: FXD ELECT TANTAL 1μF ±20% 35V	
" C450	27PF 50WV	C: FXD CER 27pF ±10% 50V	
" L451 thru " L457	TPF-0410L-150K	L: FXD Coil 15μH	
" L458 thru " L460	TPF-0410L-330K	L: FXD Coil 33μH	
" L461	TPF-0410L-4R7K	L: FXD Coil 4.7μH	
" L462	TPF-0410L-8R2K	L: FXD Coil 8.2μH	
" L463	HFC2 2.7μH	L: FXD Coil 2.7μH	
" L464	TPF-0410L-150K	L: FXD Coil 15μH	
" L465	TP-0410L-510J	L: FXD Coil 51μH	
" L466	TP-0410L-750J	L: FXD Coil 75μH	
" L467	TP-0410L-750J	L: FXD Coil 75μH	
" L468	TPF-0410L-391K	L: FXD Coil 390μH	
" L469	TPF-0410L-391K	L: FXD Coil 390μH	
" L470	TPF-0410L-150K	L: FXD Coil 15μH	
" TH472 thru " TH480	14046	Thermistor	
" K485	NR-H-12V	Reed Relay	
" K486	RZ0113	Reed Relay	
" J488	UM-LR-PC	Connector	※
PH190 - J489	UM-LR-PC	Connector	※

Parts No.	Stock No.	Description	
PH190 - TP1 thru " TP20	401-9630	Terminal	
" D511 thru " D520	IS953 1S953	Diode SI	
" R521	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R522	RD25S 18KΩJ	R: FXD CAR 18kΩ ±5% 1/4W	
" R523 thru PH190 - R526	RD25S 100KΩJ	R: FXD CAR 100kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
SG178 - IC1	LM318H	IC: Operational Amplifier	
" IC2	LM339N	IC: Quadruple Differential Comparator	
" Q11	2SC1834	Transistor SI NPN	
" Q12	2N4393	FET Junction N-Channel	
" Q13		Not assigned	
" Q14		Not assigned	
" Q15	2SA1015	Transistor SI PNP	
" Q16	2SC1834	Transistor SI NPN	
" Q17	2SA1015	Transistor SI PNP	
" Q18	2SC1834	Transistor SI NPN	
" Q19	2SA1015	Transistor SI PNP	
" Q20 thru " Q23	2SC1834	Transistor SI NPN	
" Q24 thru " Q27	2SC505	Transistor SI NPN	
" Q28 thru " Q31	2SC1834	Transistor SI NPN	
" Q32	2SC505	Transistor SI NPN	
" Q33	2SC505	Transistor SI NPN	
" Q34	2SC1834	Transistor SI NPN	
" Q35	2SC944S	Transistor SI NPN	
" Q36	2SC944S	Transistor SI NPN	
" Q37	2SA1015	Transistor SI PNP	
" Q38	2SA1015	Transistor SI PNP	
" Q39	2SC1834	Transistor SI NPN	
" Q40		Not assigned	
" Q41 thru " Q44	2SC1834	Transistor SI NPN	
" Q45	2SC507	Transistor SI NPN	
" Q46	2SA712	Transistor SI PNP	
SG178 - Q47	2SC1834	Transistor SI NPN	

Parts No.	Stock No.	Description	
SG178 - Q48	2SC1279S	Transistor SI NPN	
" D51	1S953	Diode SI	
" D52	1S953	Diode SI	
" D53	WZ-075	Zener Diode	
" D54		Not assigned	
" D55 thru " D72	1S953	Diode SI	
" R81	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R82	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R83	X6S 1KΩ	R: VAR WW 1kΩ	
" R84	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R85	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R86	RD25S 270ΩJ	R: FXD CAR 270Ω ±5% 1/4W	
" R87	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R88	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R89	X6S 10KΩJ	R: VAR WW 10kΩ	
" R90	RD25S 47KΩJ	R: FXD CAR 47kΩ ±5% 1/4W	
" R91	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R92	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R93 thru " R98		Not assigned	
" R99	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R100	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R101	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R102	RD25S 270ΩJ	R: FXD CAR 270Ω ±5% 1/4W	
" R103	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R104	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R105	CRB 1/4FX 7.5KΩ	R: FXD Metal FLM 7.5kΩ ±1% 1/4W	
" R106	RD25S 3.9KΩJ	R: FXD CAR 3.9kΩ ±5% 1/4W	
" R107	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R108	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
SG178 - R109	RD25S 3.9KΩJ	R: FXD CAR 3.9kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
SG178 - R110	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R111	X6S 2KΩ	R: VAR WW 2kΩ	
" R112	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R113	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R114	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R115	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R116	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R117	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R118	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R119 thru " R121	RD25S 3.9KΩJ	R: FXD CAR 3.9KΩ ±5% 1/4W	
" R122	R-1 22KΩJ	R: FXD CAR 22kΩ ±5% 1W	
" R123	R-1 22KΩJ	R: FXD CAR 22kΩ ±5% 1W	
" R124	RD50S 82KΩJ	R: FXD CAR 82kΩ ±5% 1/2W	
" R125	RD50S 82KΩJ	R: FXD CAR 82kΩ ±5% 1/2W	
" R126	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R127	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R128	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R129	RD25S 220ΩJ	R: FXD CAR 220Ω ±5% 1/4W	
" R130	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R131	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R132	RD25S 1.8KΩJ	R: FXD CAR 1.8kΩ ±5% 1/4W	
" R133	RD25S 15KΩJ	R: FXD CAR 15kΩ ±5% 1/4W	
" R134	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R135	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R136	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R137	RD25S 1.5KΩJ	R: FXD CAR 1.5kΩ ±5% 1/4W	
" R138	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R139	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R140	RD25S 1.8KΩJ	R: FXD CAR 1.8kΩ ±5% 1/4W	
" R141	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R142	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
SG178 - R143	R-2 22KΩJ	R: FXD CAR 22kΩ ±5% 2W	

Parts No.	Stock No.	Description	
SG178 - R144	R-2 22KΩJ	R: FXD CAR 22kΩ ±5% 2W	
" R145	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R146	RD25S 7.5KΩJ	R: FXD CAR 7.5kΩ ±5% 1/4W	
" R147	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R148	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R149	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R150	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R151	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R152	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R153	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R154	RD25S 820ΩJ	R: FXD CAR 820Ω ±5% 1/4W	
" R155	RD25S 680ΩJ	R: FXD CAR 680Ω ±5% 1/4W	
" R156 thru " R158	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R159	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R160	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R161	RD25S 470ΩJ	R: FXD CAR 470Ω ±5% 1/4W	
" R162	RD25S 3.3KΩJ	R: FXD CAR 3.3kΩ ±5% 1/4W	
" R163	RD25S 120ΩJ	R: FXD CAR 120Ω ±5% 1/4W	
" R164	RD25S 39KΩJ	R: FXD CAR 39kΩ ±5% 1/4W	
" R165	RD25S 22KΩJ	R: FXD CAR 22kΩ ±5% 1/4W	
" R166	RD25S 12KΩJ	R: FXD CAR 12kΩ ±5% 1/4W	
" R167	RD25S 68KΩJ	R: FXD CAR 68kΩ ±5% 1/4W	
" R168	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R169	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R170	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R171		Not assigned	
" R172 thru " R174	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R175	RD25S 56KΩJ	R: FXD CAR 56kΩ ±5% 1/4W	
" R176	RJ-6X 50KΩ	R: VAR CERMET 50kΩ	
" R177	RD25S 82KΩJ	R: FXD CAR 82kΩ ±5% 1/4W	
SG178 - R178	RJ-6X 200KΩ	R: VAR CERMET 200kΩ	

Parts No.	Stock No.	Description	
SG178 - R179	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R180	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R181	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R182	RD25S 1KΩJ	R: FXD CAR 1kΩ ±5% 1/4W	
" R183	RD25S 1.8KΩJ	R: FXD CAR 1.8kΩ ±5% 1/4W	
" R184	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R185	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R186	RD25S 2.2KΩJ	R: FXD CAR 2.2kΩ ±5% 1/4W	
" R187	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R188		Not assigned	
" C191	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C192	8PF 50WV	C: FXD CER 8pF ±10% 50V	
" C193	2PF 50WV	C: FXD CER 2pF ±10% 50V	
" C194	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C195	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C196	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C197	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C198	25TK100	C: FXD ELECT 100μ 25V	
" C199	25TK100	C: FXD ELECT 100μ 25V	
" C200	0.047UF 50WV	C: FXD CER 0.047μF +80, -20% 50V	
" C201 thru " C203	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C204	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C205	221M3502 106M	C: FXD ELECT TANTAL 10μF ±20% 35V	
" C206	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C207		Not assigned	
" C208	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C209	470PF 50WV	C: FXD CER 470pF ±10% 50V	
" C210	441N1003223K	C: FXD Polyester FLM 0.022μF ±10% 100V	
" C211	DM10C010D5	C: FXD DIPPED MICA 1pF ±0.5% 500V	
SG178 - C212	ECV-1ZW06X31	C: VAR CER 6pF	

Parts No.	Stock No.	Description	
SG178 - C213 thru " C217	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C218	25TH10	C: FXD ELECT 10μF 25V	
" C219	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C220	25TH10	C: FXD ELECT 10μF 25V	
" C221	0.1UF 25WV	C: FXD CER 0.1μF +80, -20% 25V	
" C222	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C223	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C224	4PF 50WV	C: FXD CER 4pF ±10% 50V	
" L231	TPF0410-391K	L: FXD Coil 390μH	
" L232	TPF0410-391K	L: FXD Coil 390μH	
" J236	PCN6B-10P-2.5DS	Connector	※
" TP1	401-9630	Terminal	
" R241	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R242	RD25S 5.6KΩJ	R: FXD CAR 5.6kΩ ±5% 1/4W	
" R243	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R244	CRB 1/4FX 6.8KΩ	R: FXD Metal FLM 6.8kΩ ±1% 1/4W	
" R245	CRB 1/4FX 6.8KΩ	R: FXD Metal FLM 6.8kΩ ±1% 1/4W	
" R246	RD25S 33ΩJ	R: FXD CAR 33Ω ±5% 1/4W	
" R247	RD25S 1.8KΩJ	R: FXD CAR 1.8kΩ ±5% 1/4W	
" R248	RD25S 1.2KΩJ	R: FXD CAR 1.2kΩ ±5% 1/4W	
" R249	RD25S 330ΩJ	R: FXD CAR 330Ω ±5% 1/4W	
" R250	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R251	RD25S 8.2KΩJ	R: FXD CAR 8.2kΩ ±5% 1/4W	
" R252	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R253	X6S 1KΩJ	R: VAR WW 1kΩ	
" R254	RD25S 4.7KΩJ	R: FXD CAR 4.7kΩ ±5% 1/4W	
" R255	RD25S 6.8KΩJ	R: FXD CAR 6.8kΩ ±5% 1/4W	
" R256	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
SG178 - R257	RD25S 1.8KΩJ	R: FXD CAR 1.8kΩ ±5% 1/4W	

Parts No.	Stock No.	Description	
SG178 - Q261	MP311	Transistor	
" Q262 thru SG178 - Q264	2SA1015	Transistor SI PNP	

Parts No.	Stock No.	Description	
SG204 - Q1	2SC1834	Transistor SI NPN	
" D6	1S953	Diode SI	
" D7	1S953	Diode SI	
" D8	WZ-130	Zener Diode	
" R11	RD50S 33ΩJ	R: FXD CAR 33Ω ±5% 1/2W	
" R12	RD25S 100ΩJ	R: FXD CAR 100Ω ±5% 1/4W	
" R13	RD25S 15ΩJ	R: FXD CAR 15Ω ±5% 1/4W	
" R14	RD25S 10KΩJ	R: FXD CAR 10kΩ ±5% 1/4W	
" R15	RD25S 33KΩJ	R: FXD CAR 33kΩ ±5% 1/4W	
" C17	111M2502 686M	C: FXD ELECT TANTAL 68μF ±20% 25V	
" C18	25TK100	C: FXD ELECT 100μF 25V	
" C19	0.01UF 50WV	C: FXD CER 0.01μF +80, -20% 50V	
" C20	16TK1000	C: FXD ELECT 1000μF 16V	
" L23	TPF0410 391	L: FXD Coil 390μH	
" K26	DIP-1M-12	Reed Relay	
" J29	PCN6	Connector	※
" J30	PCN6-10S-2.5E	Connector	※
SG204 - J31	PCN6	Connector	※

Parts No.	Stock No.	Description	
MEP155, 153, 152 - Q1 thru " Q3	FJ-901F	Transistor SI NPN	
" C21	BLPW1E681NA	C: FXD BL 680pF ±0.05% 25V	
" C22	BLPW1E681NA	C: FXD BL 680pF ±0.05% 25V	
" C23	BLPW1E331NA	C: FXD BL 330pF ±0.05% 25V	
" C24 thru " C26	BLPW1E681NA	C: FXD BL 680pF ±0.05% 25V	
" C27	C15NP001H120K	C: FXD CHIP 12pF ±10% 50V	
" C28	BLPW1E681NA	C: FXD BL 680pF ±0.05% 25V	
" C29	BLPW1E681NA	C: FXD BL 680pF ±0.05% 25V	
" C30	C15SL1H101K	C: FXD CHIP 100pF ±10% 50V	
" C31		Not assigned	
" C32	BLPW1E222NA	C: FXD BL 2200pF ±0.05% 25V	
" C33	BLPW1E222NA	C: FXD BL 2200pF ±0.05% 25V	
" C34	TAXH20V2R2	C: FXD ELECT TANTAL 2.2µF ±20% 20V	
" C35	TAXH10V330	C: FXD ELECT TANTAL 33µF ±20% 10V	
" C56 thru " C62	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	
" C63	BLPW1E331NA	C: FXD BL 330pF ±0.05% 25V	
" C64	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	
" C65	KFD51AYZB102P50	C: FXD Feed-through 1000pF +100, -0% 50V	
MEP155, 153, 152 - R71	CHR-1 150ΩJ	R: FXD CHIP 150Ω ±5% 1/32W	

Parts No.	Stock No.	Description	
CBL - Ca1	KCA-25A-15	SMA-SMA Cable	
" Ca2	KCA-25A-16	SMA-SMA Cable	
" Ca3	KCA-25A-17	SMA-SMA Cable	
" Ca4	KCA-25A-03	SMA-SMA Cable	
" Ca5	KCA-25A-18	SMA-SMA Cable	
" Ca6	KCA-33A-01	BNC-UN Cable	
" Ca7	KCA-33A-01	BNC-UM Cable	
" Ca8	KCA-6A-07	UM-UM Cable	
" Ca9	KCA-6A-01	UM-UM Cable	
" Ca10	KCA-6A-01	UM-UM Cable	
" Ca11	KCA-6A-08	UM-UM Cable	
" Ca12	KCA-25A-19	SMA-SMA Cable	
" Ca13	KCA-25A-05	SMA-SMA Cable	
" Ca14	KCA-25A-20	SMA-SMA Cable	
" Ca15	KCA-25A-21	SMA-SMA Cable	
" Ca16	KCA-25A-17	SMA-SMA Cable	
" Ca17	KCA-25A-24	SMA-SMA Cable	
" Ca18	KCA-25A-25	SMA-SMA Cable	
" Ca19	KCA-25A-23	SMA-SMA Cable	
" Ca20	KCA-25A-21	SMA-SMA Cable	
" Ca21	KCA-25A-22	SMA-SMA Cable	
CBL - Ca22	KCA-25A-18	SMA-SMA Cable	

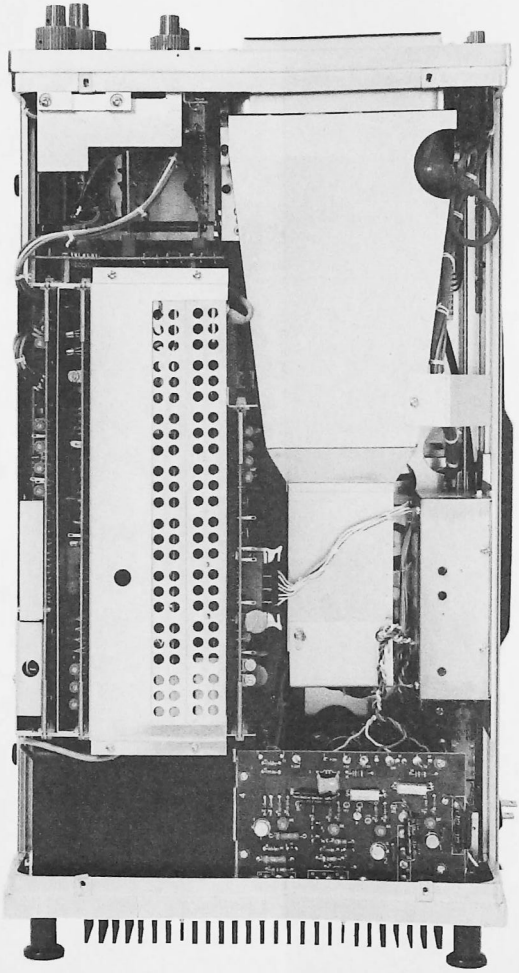
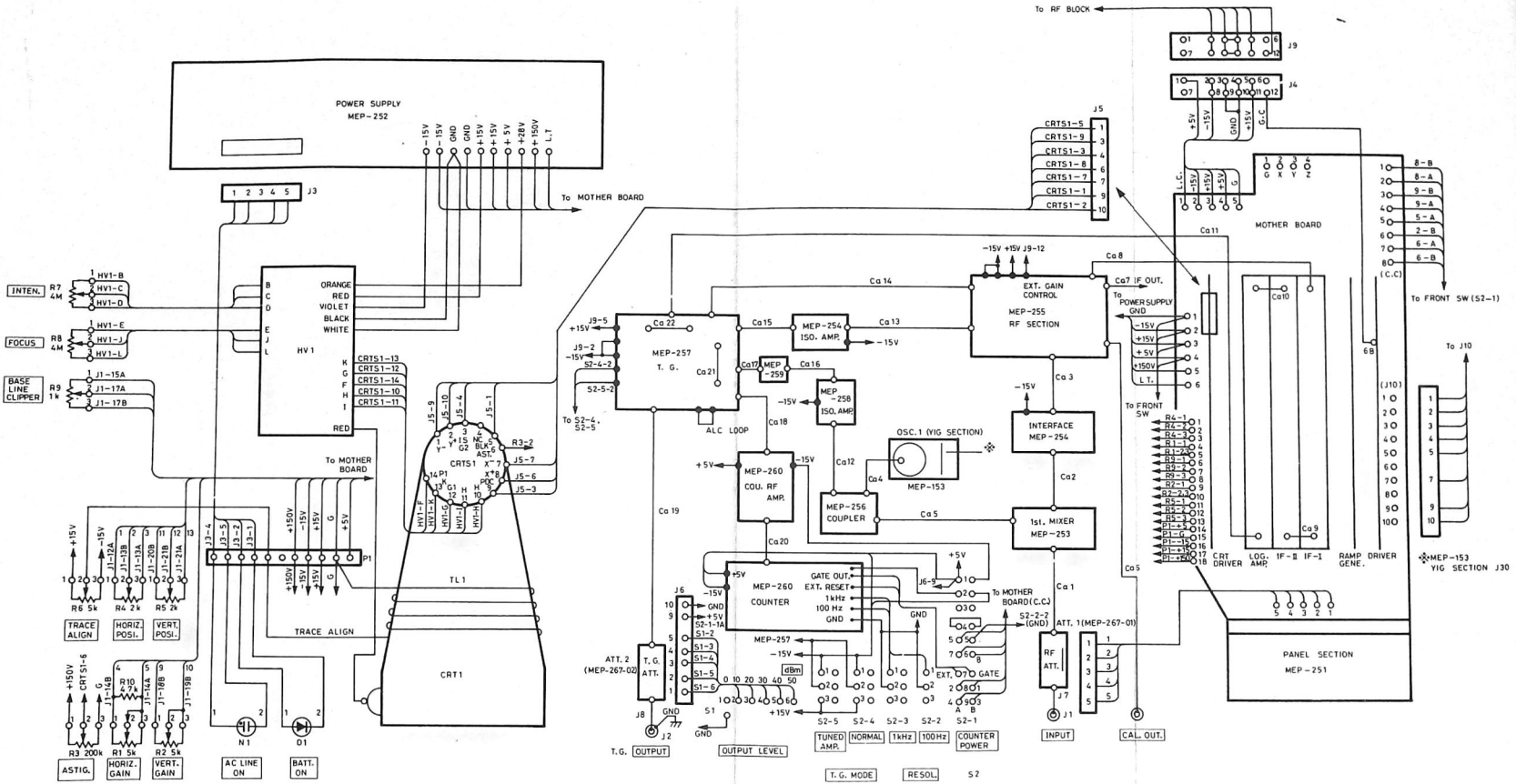


Fig. 8 – 1 -*TR*-4122B TOP VIEW



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-TR-4122B
SCHEMATIC SECTION

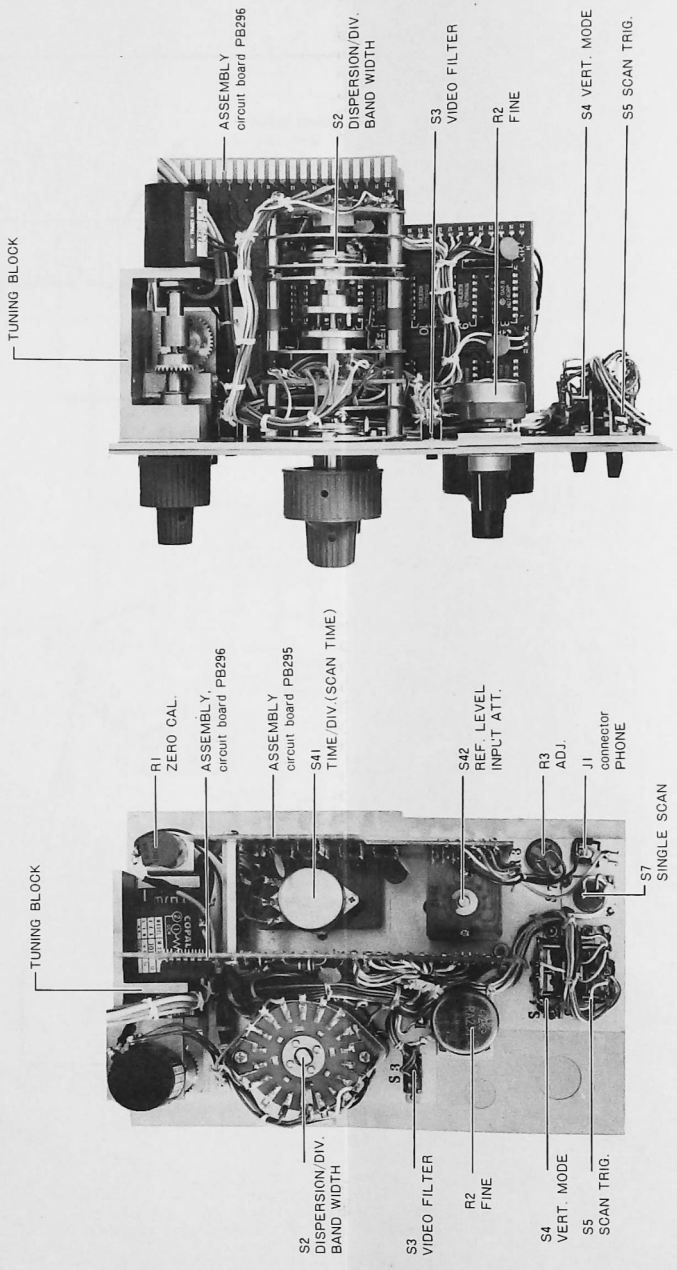
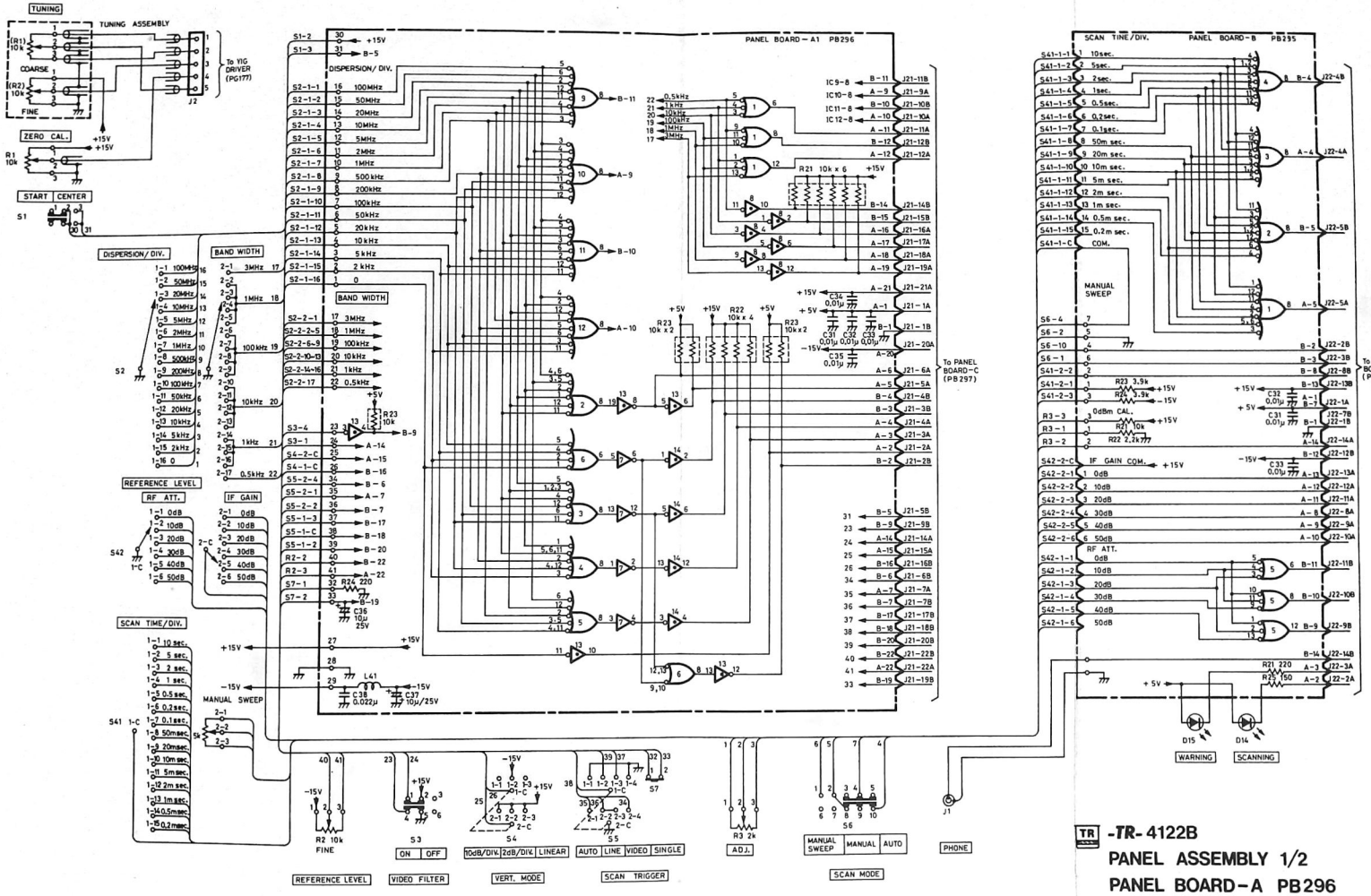


Fig. 8 – 2 -*TR*-4122B PANEL ASSEMBLY



-TR-4122B
PANEL ASSEMBLY 1/2
PANEL BOARD-A PB296
PANEL BOARD-B PB295

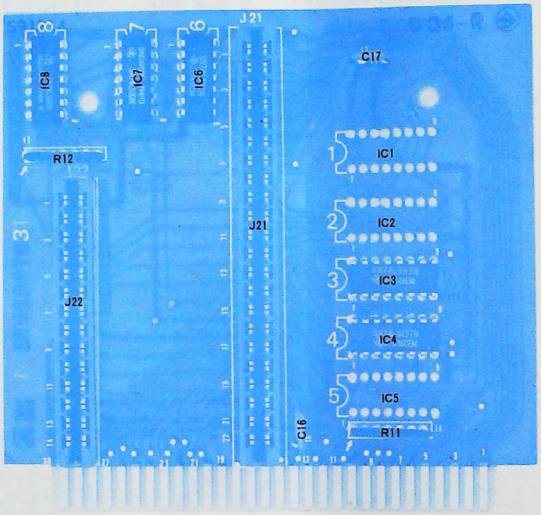
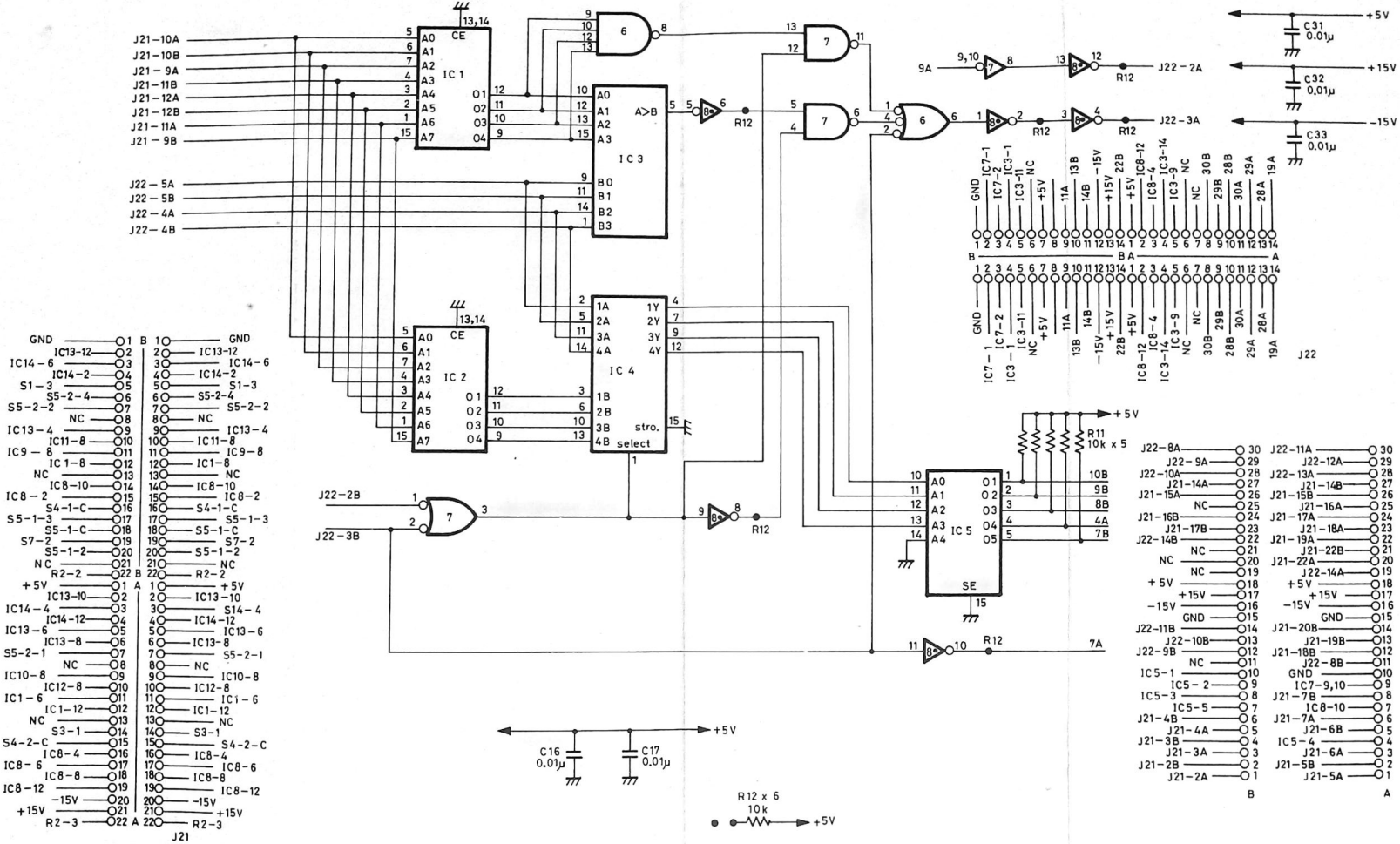


Fig. 8 – 3 Locations & Diagrams, PB297 (PANEL BOARD-C Assy)



-TR-4122B
PANEL ASSEMBLY 2/2
PANEL BOARD-C PB297

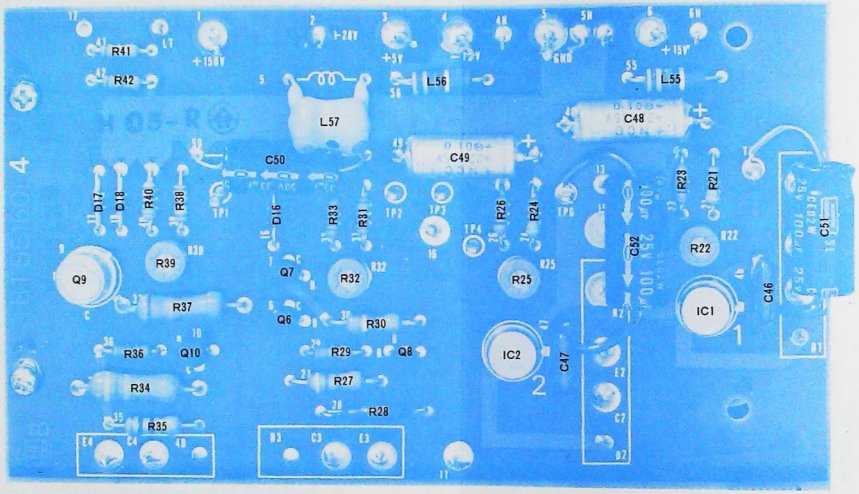
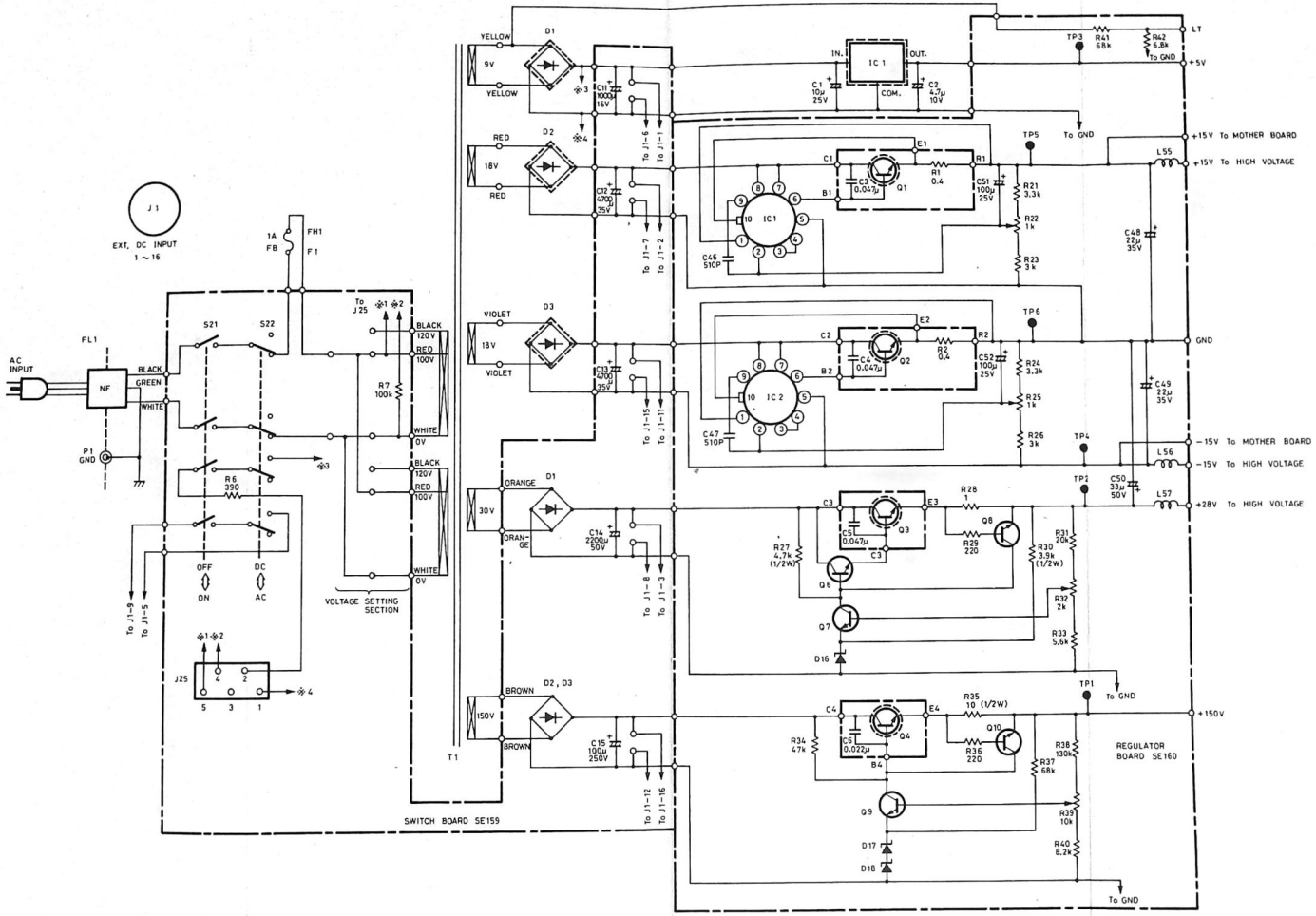


Fig. 8 – 4 Locations, SE160 (REGULATOR BOARD)



TR -TR-4122B

POWER SUPPLY (MEP-252)

SE159 SWITCH BOARD

SE160 REGURATOR BOARD

0995006-004-A

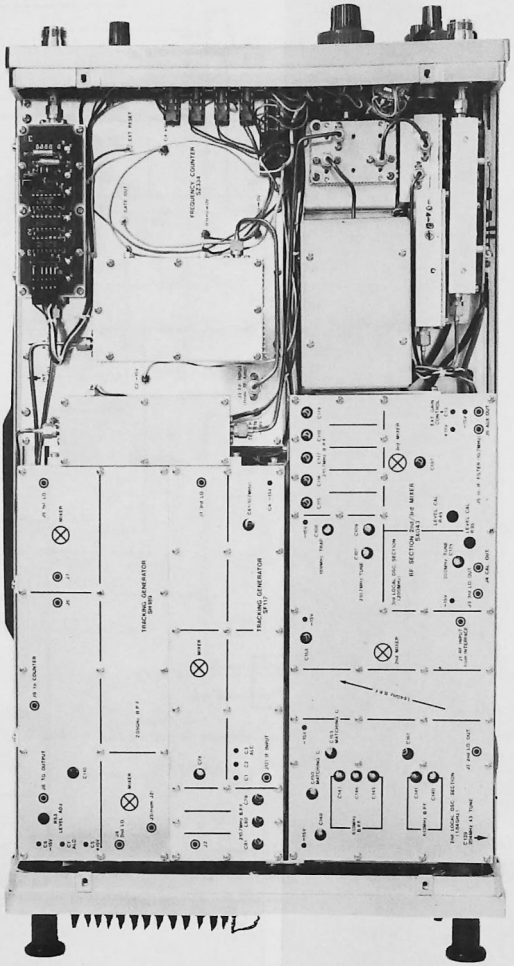
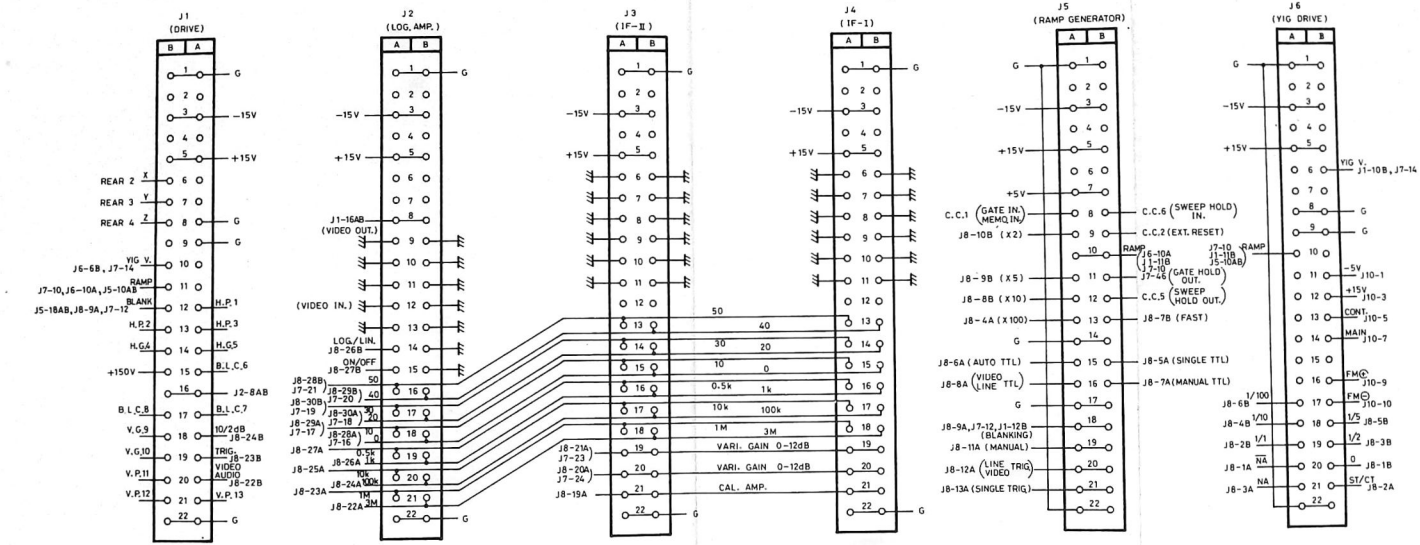


Fig. 8 – 5 -*TR*-4122B BOTTOM VIEW



-TR-4122B
MOTHER BOARD 1/2
MZ337

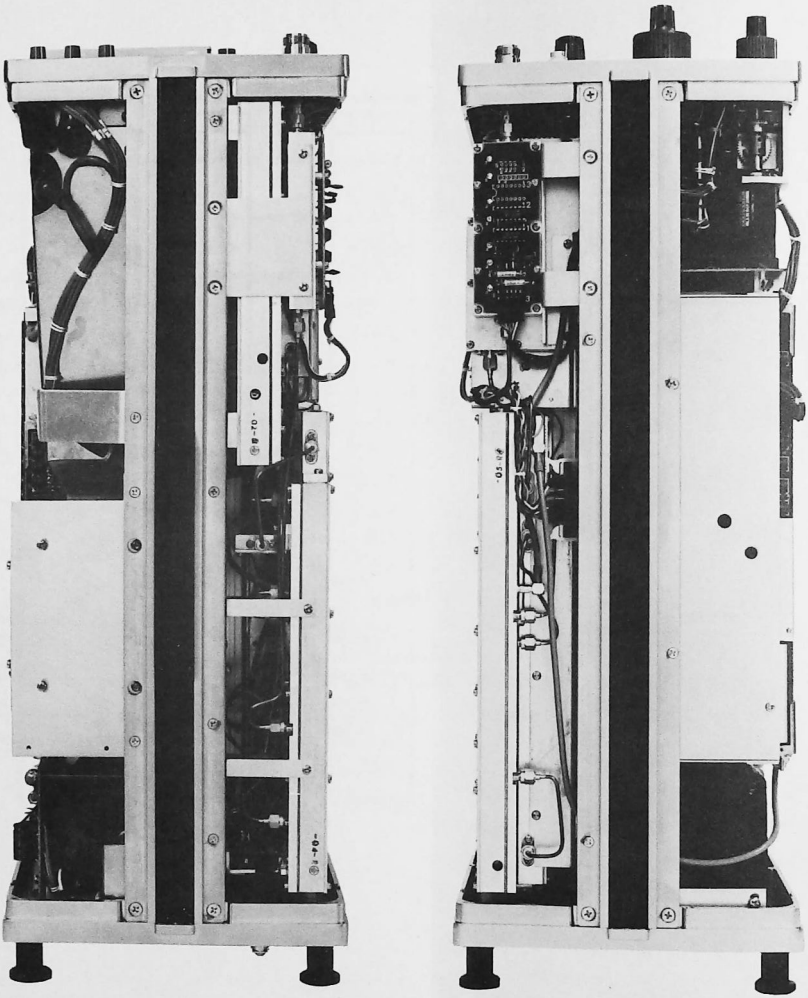
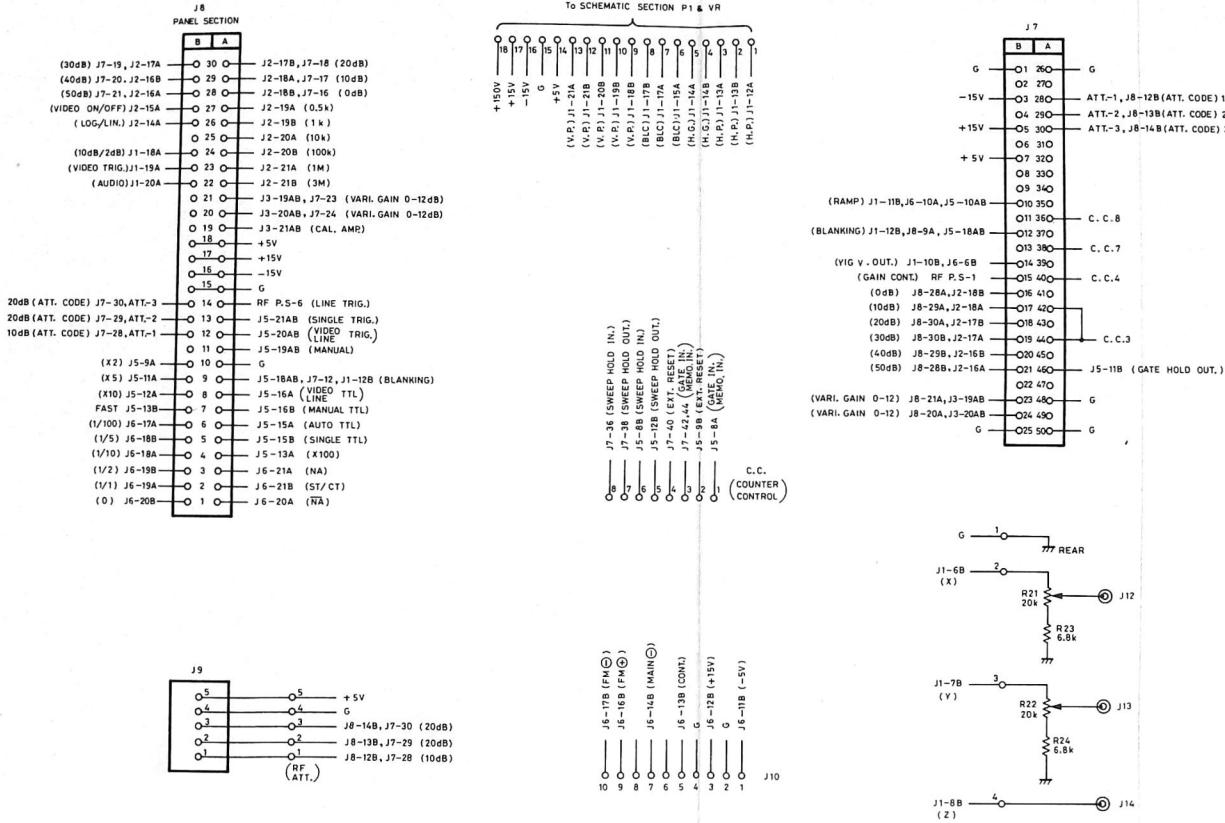


Fig. 8 – 6 -*TR*-4122B SIDE VIEW


J8
PANEL SECTION
B A
(30dB) J7-19, J2-17A — 30 — J2-17B, J7-18 (20dB)
(40dB) J7-20, J2-16B — 29 — J2-18A, J7-17 (10dB)
(50dB) J7-21, J2-16A — 28 — J2-18B, J7-16 (0dB)
(VIDEO ON/OFF) J2-15A — 27 — J2-19A (0.5k)
(LOG/LIN.) J2-14A — 26 — J2-19B (1k)
25 — J2-20A (10k)
(10dB/2dB) J1-18A — 24 — J2-20B (100k)
(VIDEO TRIG.) J1-19A — 23 — J2-21A (1M)
(AUDIO) J1-20A — 22 — J2-21B (3M)
21 — J3-19AB, J7-23 (VARI. GAIN 0-12dB)
20 — J3-20AB, J7-24 (VARI. GAIN 0-12dB)
19 — J3-21AB (CAL. AMP.)
18 — +5V
17 — +15V
16 — −15V
15 — G
20dB (ATT. CODE) J7-30, ATT.-3 — 14 — RF P.S-6 (LINE TRIG.)
20dB (ATT. CODE) J7-29, ATT.-2 — 13 — J5-21AB (SINGLE TRIG.)
10dB (ATT. CODE) J7-28, ATT.-1 — 12 — J5-20AB (VIDEO LINE TRIG.)
11 — J5-19AB (MANUAL)
(X2) J5-9A — 10 — G
(X5) J5-11A — 9 — J5-18AB, J7-12, J1-12B (BLANKING)
(X10) J5-12A — 8 — J5-16A (VIDEO LINE TTL)
FAST J5-13B — 7 — J5-16B (MANUAL TTL)
(1/100) J6-17A — 6 — J5-15A (AUTO TTL)
(1/5) J6-18B — 5 — J5-15B (SINGLE TTL)
(1/10) J6-18A — 4 — J5-13A (X100)
(1/2) J6-19B — 3 — J6-21A (NA)
(1/1) J6-19A — 2 — J6-21B (ST/CT)
(0) J6-20B — 1 — J6-20A (NA)
To SCHEMATIC SECTION P1 & VR
16 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
+15V +15V −15V G +5V (V.P.) J1-21A (V.P.) J1-21B (V.P.) J1-20B (V.P.) J1-19B (V.P.) J1-18B (BLC) J1-17B (BLC) J1-17A (BLC) J1-15A (H.G.) J1-14A (H.G.) J1-14B (H.P.) J1-13A (H.P.) J1-13B (H.P.) J1-12A
From RF SECTION
(10.7MHz EXT. OUT.)
J7
B A
G — 1 26 — G
2 27
−15V — 3 28 — ATT.-1, J8-12B (ATT. CODE) 10dB
4 29 — ATT.-2, J8-13B (ATT. CODE) 20dB
+15V — 5 30 — ATT.-3, J8-14B (ATT. CODE) 20dB
6 31
+5V — 7 32
8 33
9 34
(RAMP) J1-11B, J6-10A, J5-10AB — 10 35
11 36 — C.C.8
(BLANKING) J1-12B, J8-9A, J5-18AB — 12 37
13 38 — C.C.7
(YIG V.OUT.) J1-10B, J6-6B — 14 39
(GAIN CONT.) RF P.S-1 — 15 40 — C.C.4
(0dB) J8-28A, J2-18B — 16 41
(10dB) J8-29A, J2-18A — 17 42
(20dB) J8-30A, J2-17B — 18 43
(30dB) J8-30B, J2-17A — 19 44 — C.C.3
(40dB) J8-29B, J2-16B — 20 45
(50dB) J8-28B, J2-16A — 21 46 — J5-11B (GATE HOLD OUT.)
22 47
(VARI. GAIN 0-12) J8-21A, J3-19AB — 23 48 — G
(VARI. GAIN 0-12) J8-20A, J3-20AB — 24 49
G — 25 50 — G
MEP252
6 5 4 3 2 1
J8-14A +150V +5V +15V −15V G
(LINE TRIG.)
(GAIN CONT.) J7-15 — 1
−15V — 2
+15V — 3
+5V — 4
G — 5
To RF SECTION
J7-36 (SWEEP HOLD IN.)
J7-38 (SWEEP HOLD OUT.)
J5-8B (SWEEP HOLD IN.)
J5-12B (SWEEP HOLD OUT.)
J7-40 (EXT. RESET)
J7-42,44 (GATE IN, MEMO IN.)
J5-9B (EXT. RESET)
J5-8A (GATE IN, MEMO IN.)
8 7 6 5 4 3 2 1
C.C. (COUNTER CONTROL)
J9
5 4 3 2 1
5 — +5V
4 — G
3 — J8-14B, J7-30 (20dB)
2 — J8-13B, J7-29 (20dB)
1 — J8-12B, J7-28 (10dB)
(RF ATT.)
J6-17B (FM⊖)
J6-16B (FM⊕)
J6-14B (MAIN⊖)
J6-13B (CONT.)
G
J6-12B (+15V)
G
J6-11B (−5V)
10 9 8 7 6 5 4 3 2 1
J10
G — 1 — REAR
J1-6B (X) — 2 — R21 20k — J12
R23 6.8k
J1-7B (Y) — 3 — R22 20k — J13
R24 6.8k
J1-8B (Z) — 4 — J14

-TR-4122B
MOTHER BOARD 2/2
MZ337

0995006-006-A

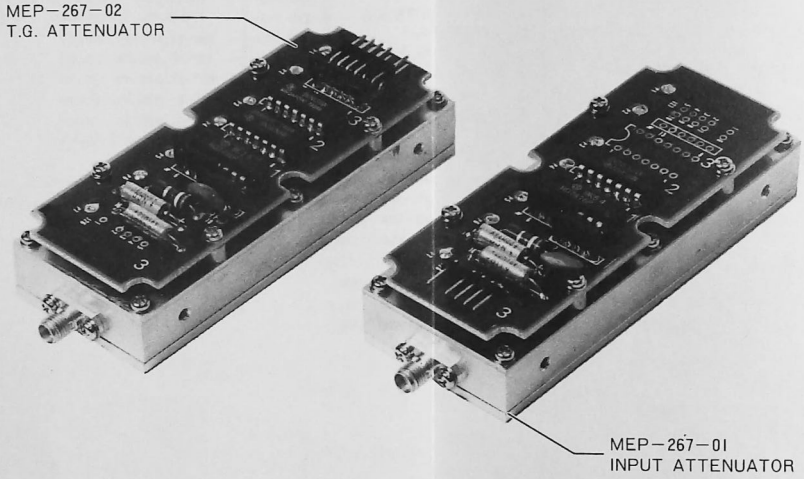
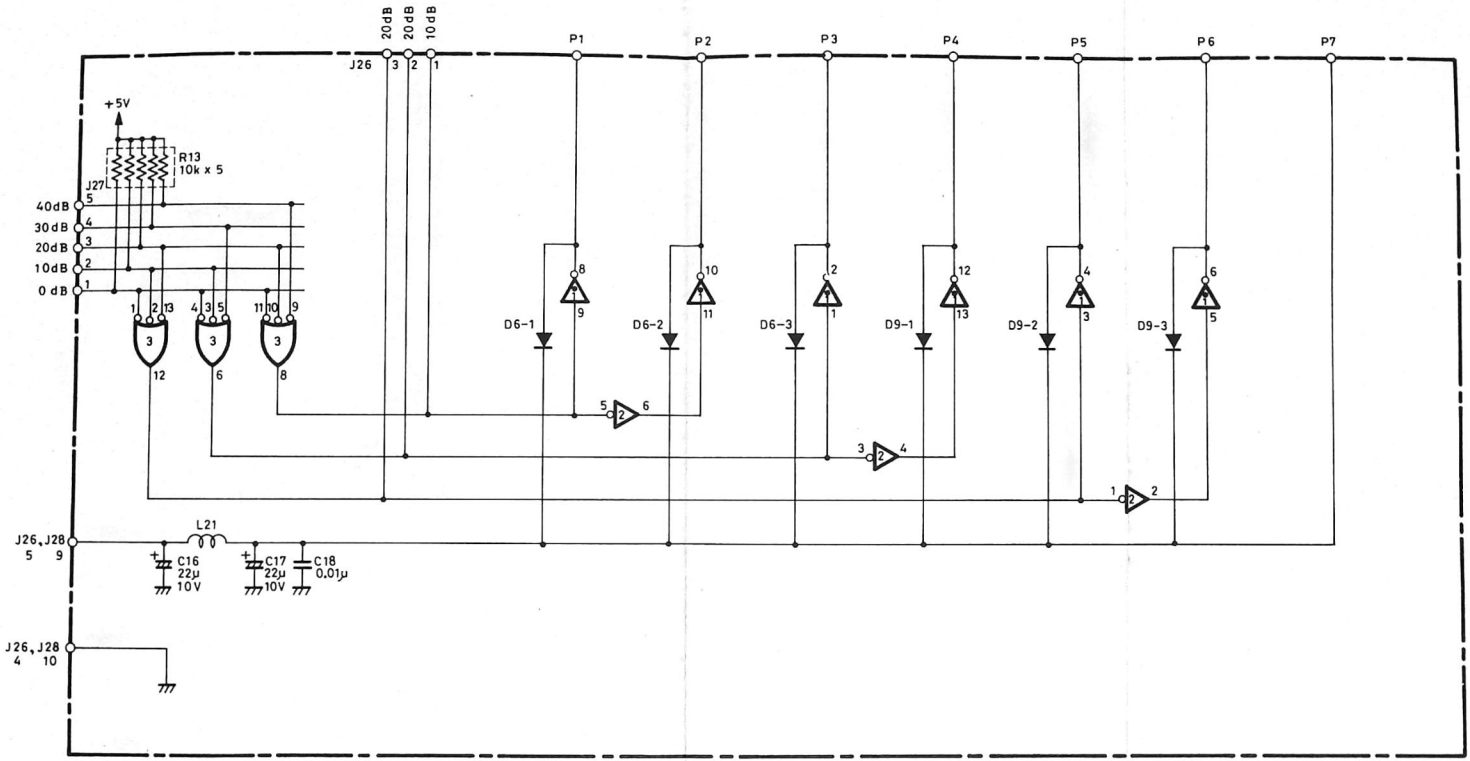


Fig. 8 – 7 T.G./INPUT ATT. (MEP-267 01/02) Ext. Views



J26 \ ATT. dB	0	10	20	30	40	50
1	H	L	H	L	H	L
2	H	H	L	H	L	L
3	H	H	H	L	L	L

0995006-007-A

TR -TR-4122B
T.G/INPUT ATT. (MEP-267) 1/2
SP014 ATT. CONTROL

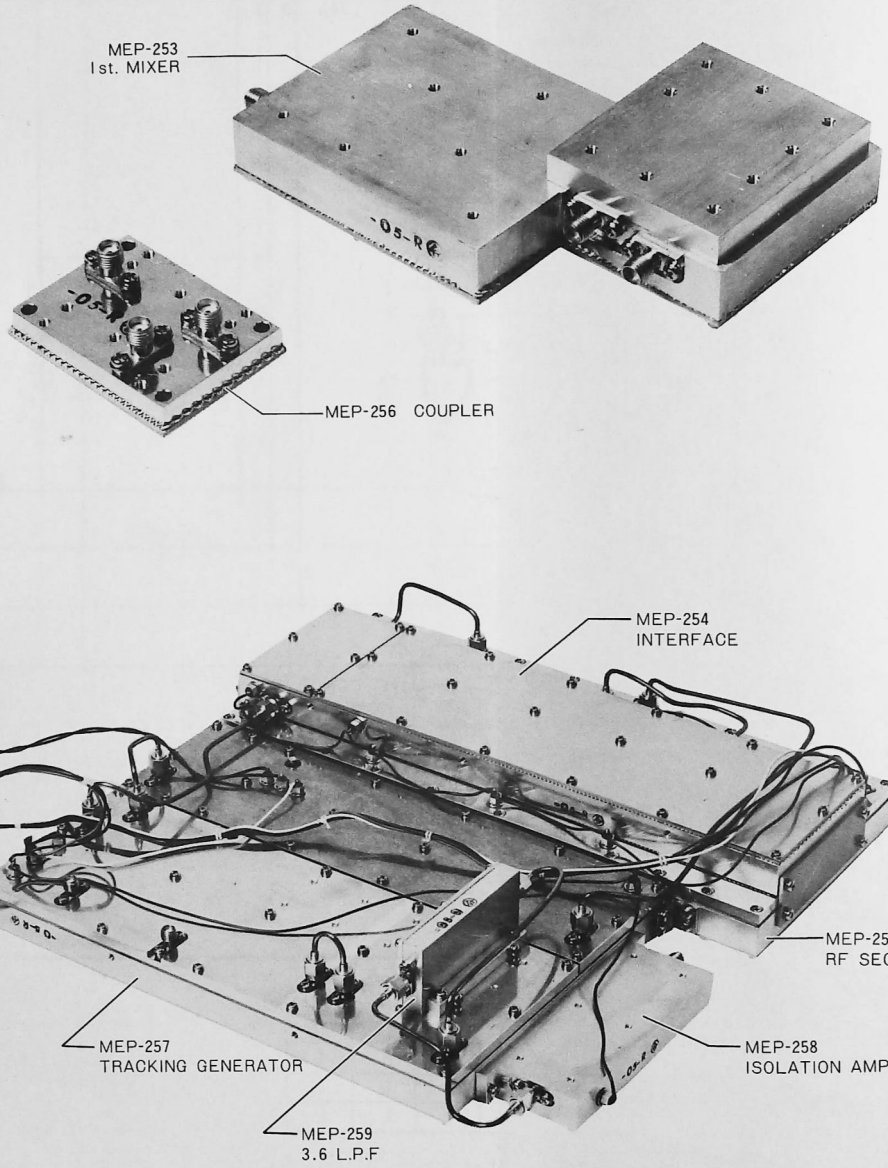
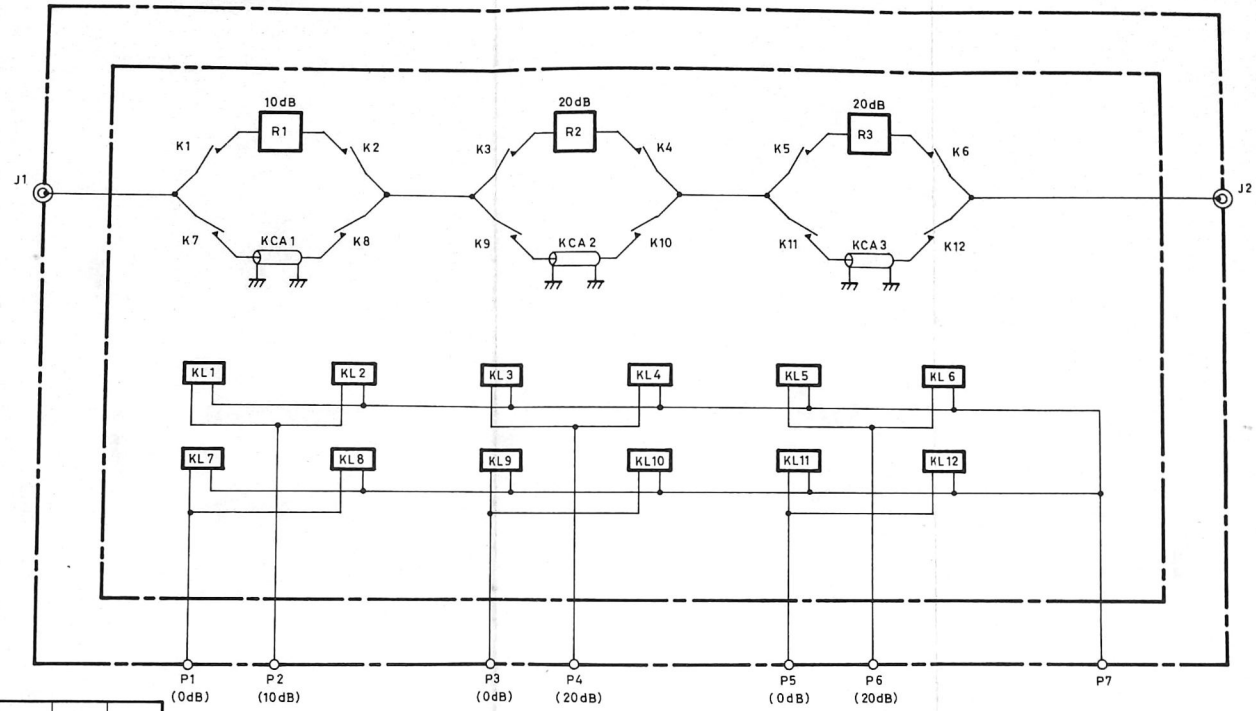


Fig. 8 – 8 MEP-253, MEP-254, MEP-256 Ext. Views



	P2		P4		P6		P1		P3		P5	
	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12
0 dB	X	X	X	X	X	X	O	O	O	O	O	O
10 dB	O	O	X	X	X	X	X	X	O	O	O	O
20dB	X	X	O	O	X	X	O	O	X	X	O	O
30dB	O	O	X	X	O	O	X	X	O	O	X	X
40dB	X	X	O	O	O	O	O	O	X	X	X	X
50 dB	O	O	O	O	O	O	X	X	X	X	X	X

O : RELAY ON H
X : RELAY OFF L

0995006-008-A

TR -TR-4122B
T.G/INPUT ATT. (MEP-267) 2/2
SA041 ATTENUATION BOARD

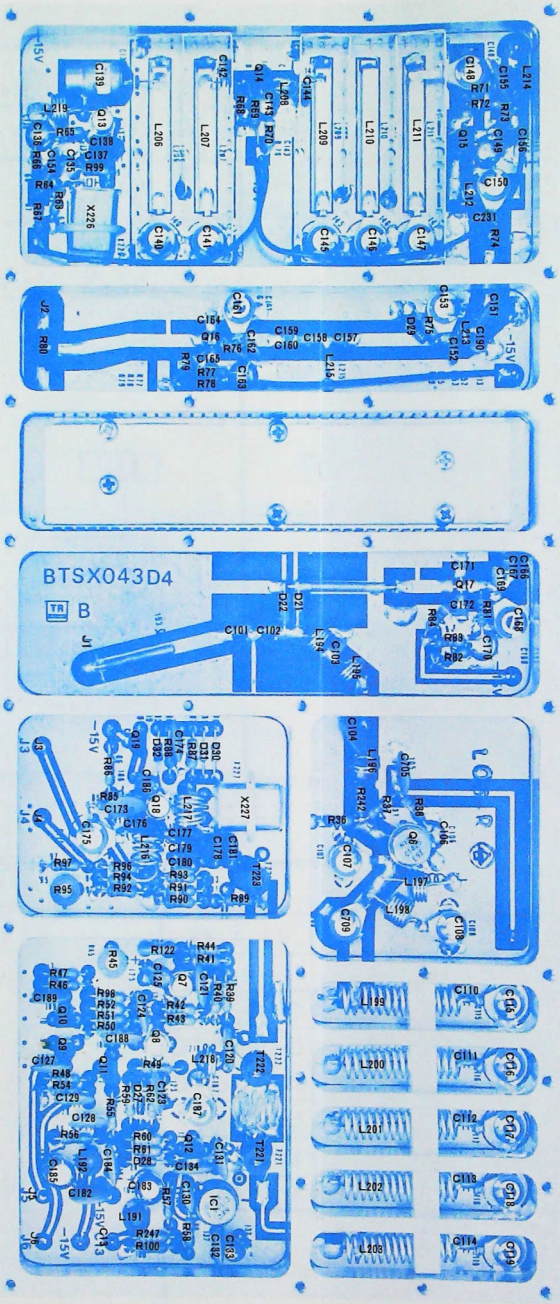
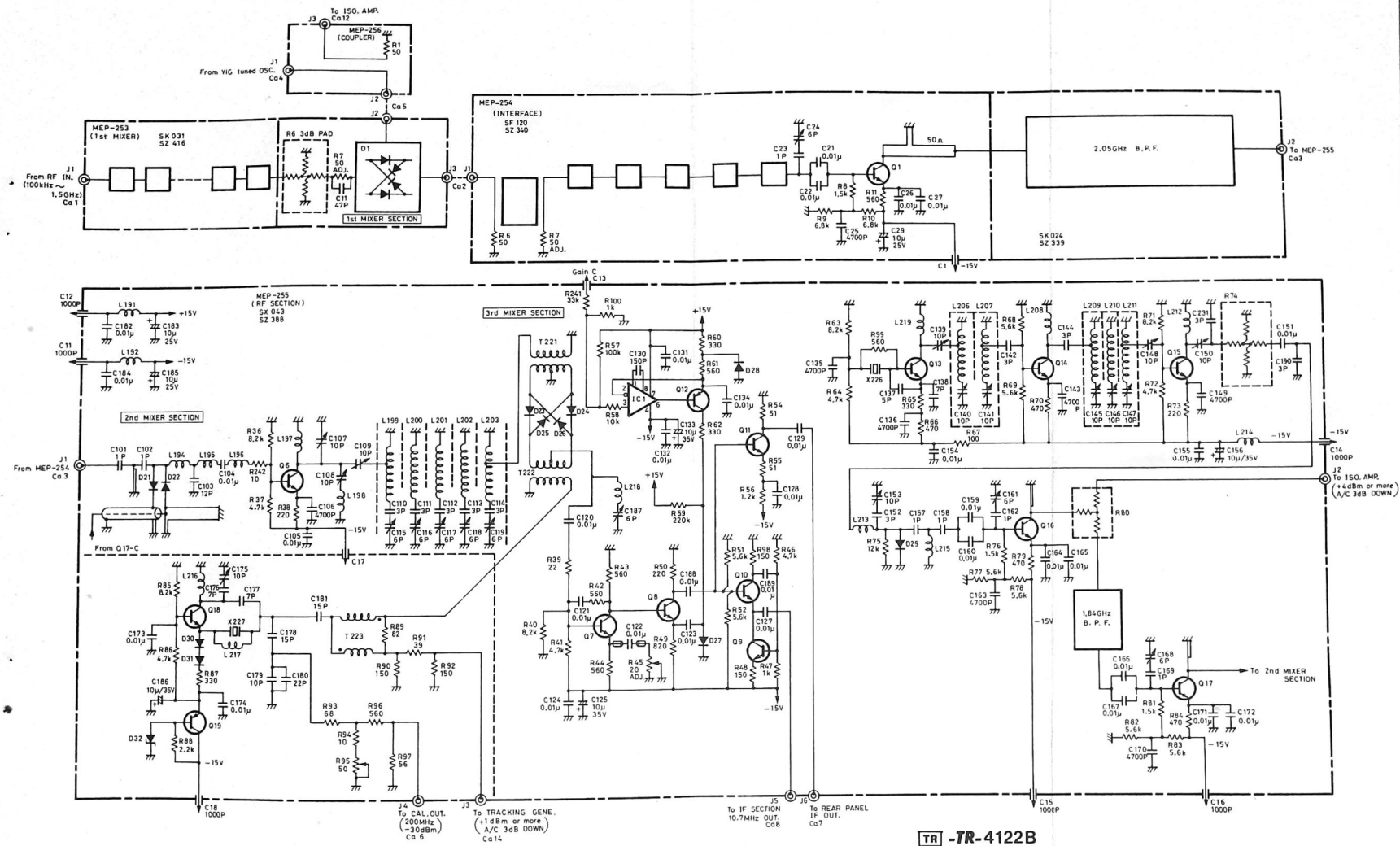


Fig. 8 – 9 Locations, MEP-255 (RF SECTION)



TR -TR-4122B

1st. MIXER, INTERFACE, RF SECTION & COUPLER (MEP-253, MEP-254, MEP-255, MEP-256)

0995006 - 009 - A

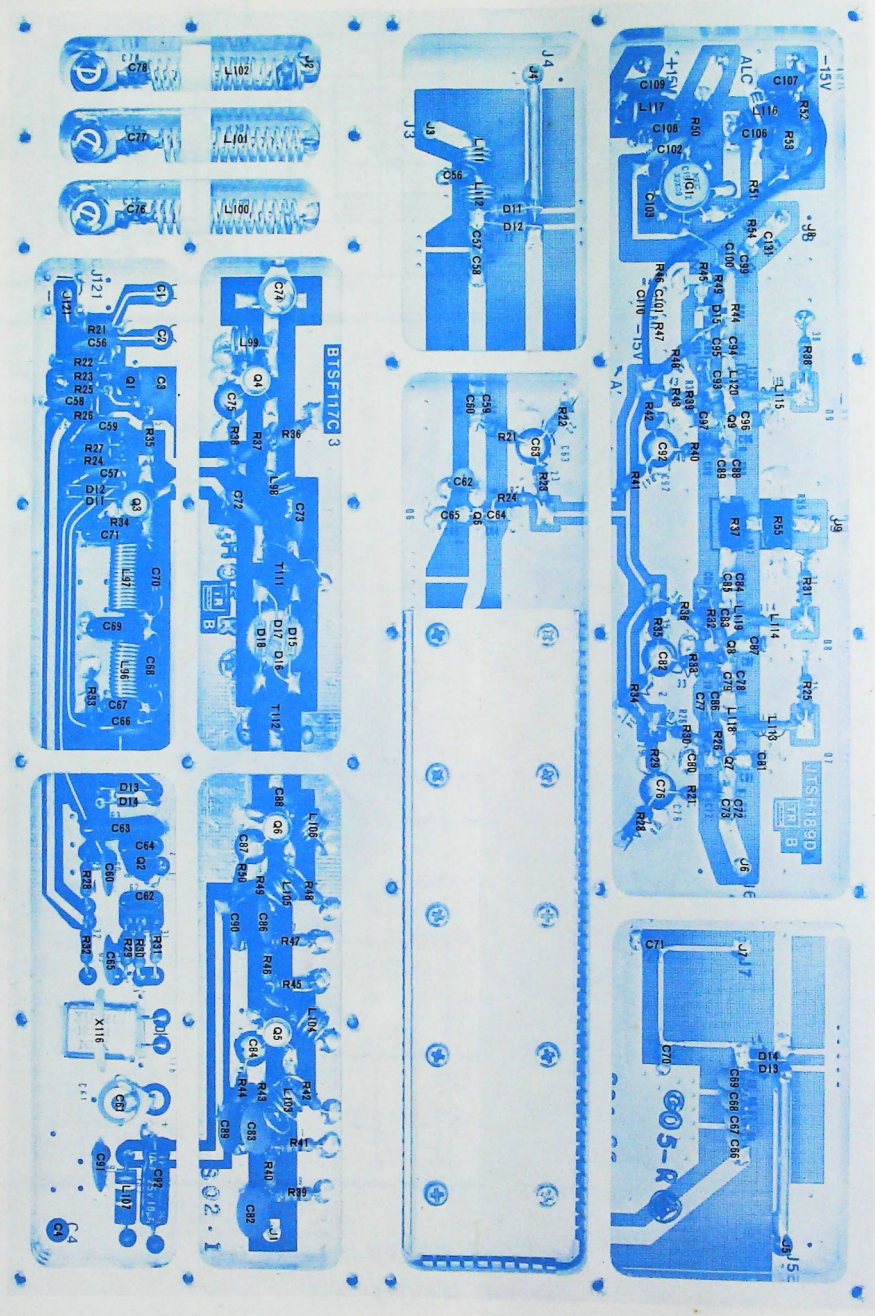
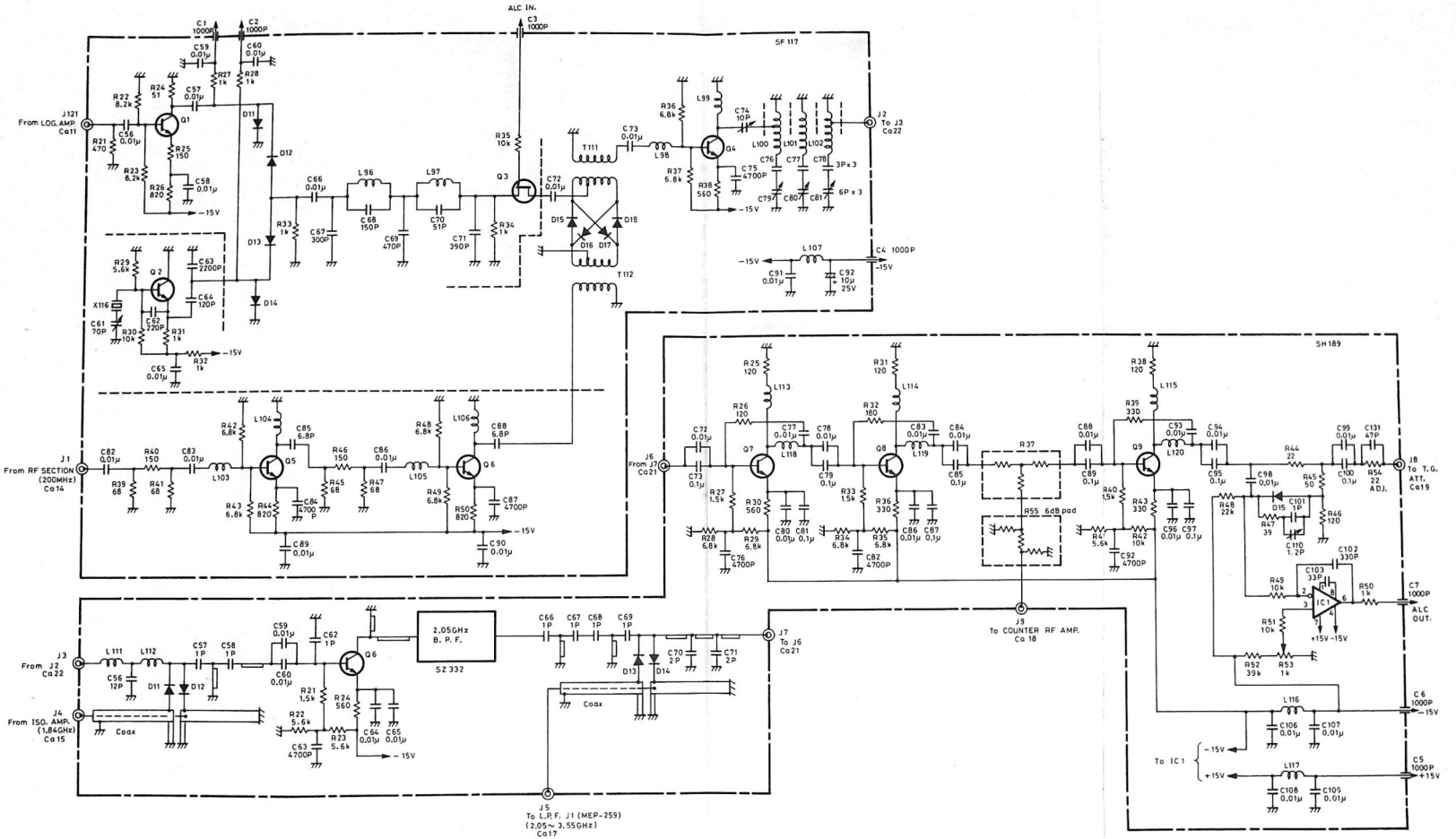


Fig. 8 – 10 Locations & Diagrams, MEP-257 (TRACKING GENERATOR)



TR -TR- 4122B

TRACKING GENERATOR (MEP-257)

SF117 210MHz T.G.

SH189 T.G. RF SECTION

0995006-010-A

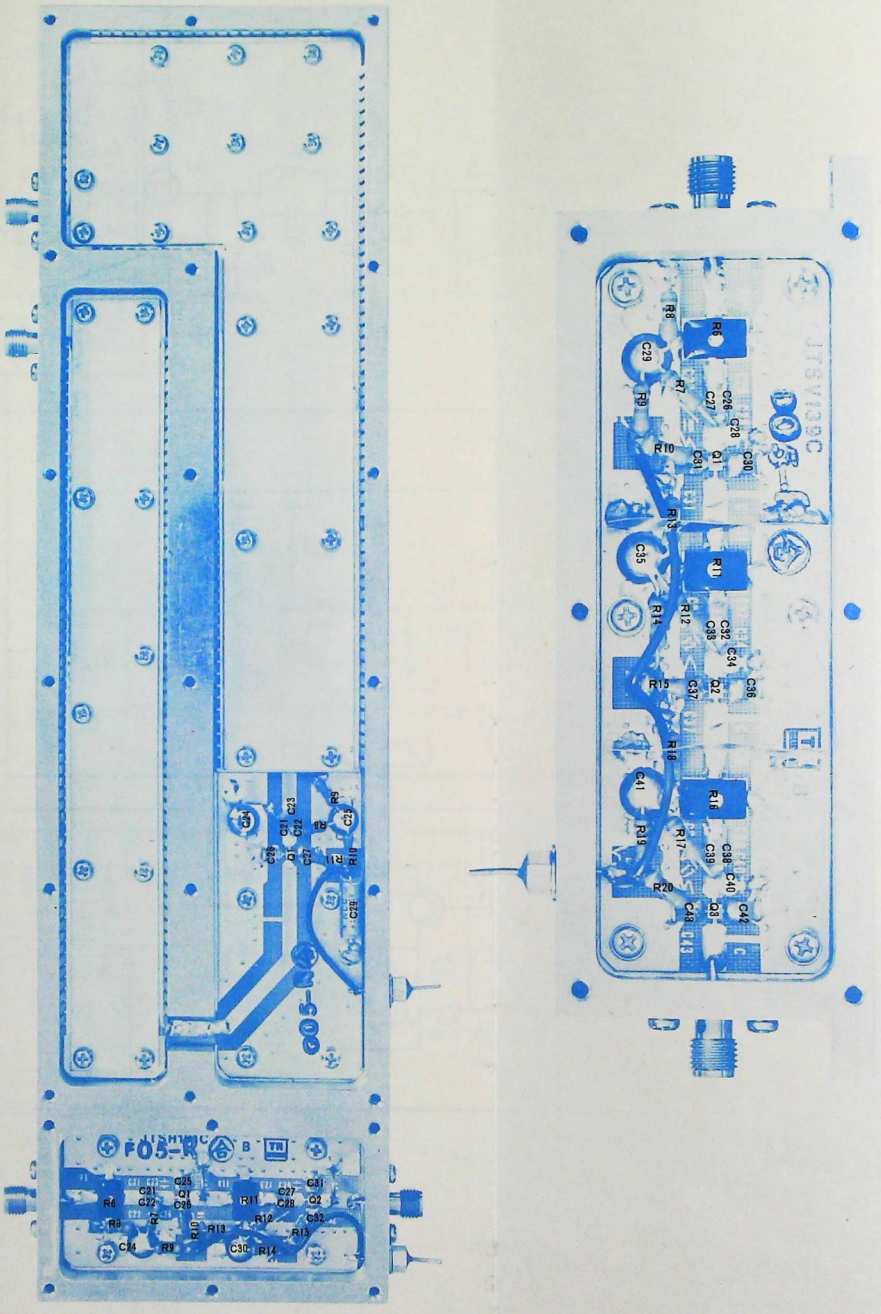
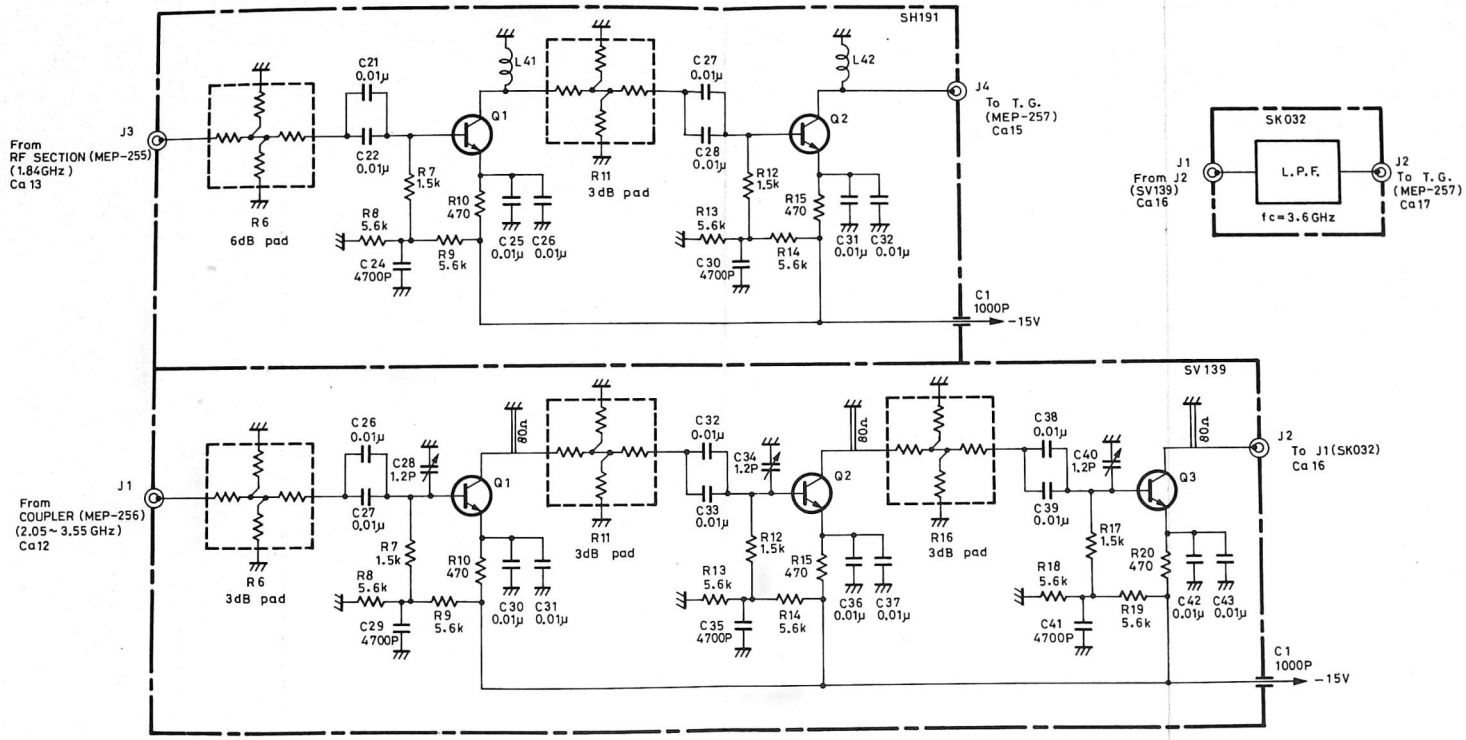


Fig. 8 – 11 Locations & Diagrams, MEP-254/258 (T.G. ISOLATION AMP.)



TR -TR-4122B

T.G. ISOLATION AMP.

(MEP-254-02) SH191 ISOLATION AMP. 1.84GHz

(MEP-258) SV139 ISOLATION AMP. 2.05~3.55GHz

(MEP-259) SK032 ISOLATION FILTER

0995006-011-A

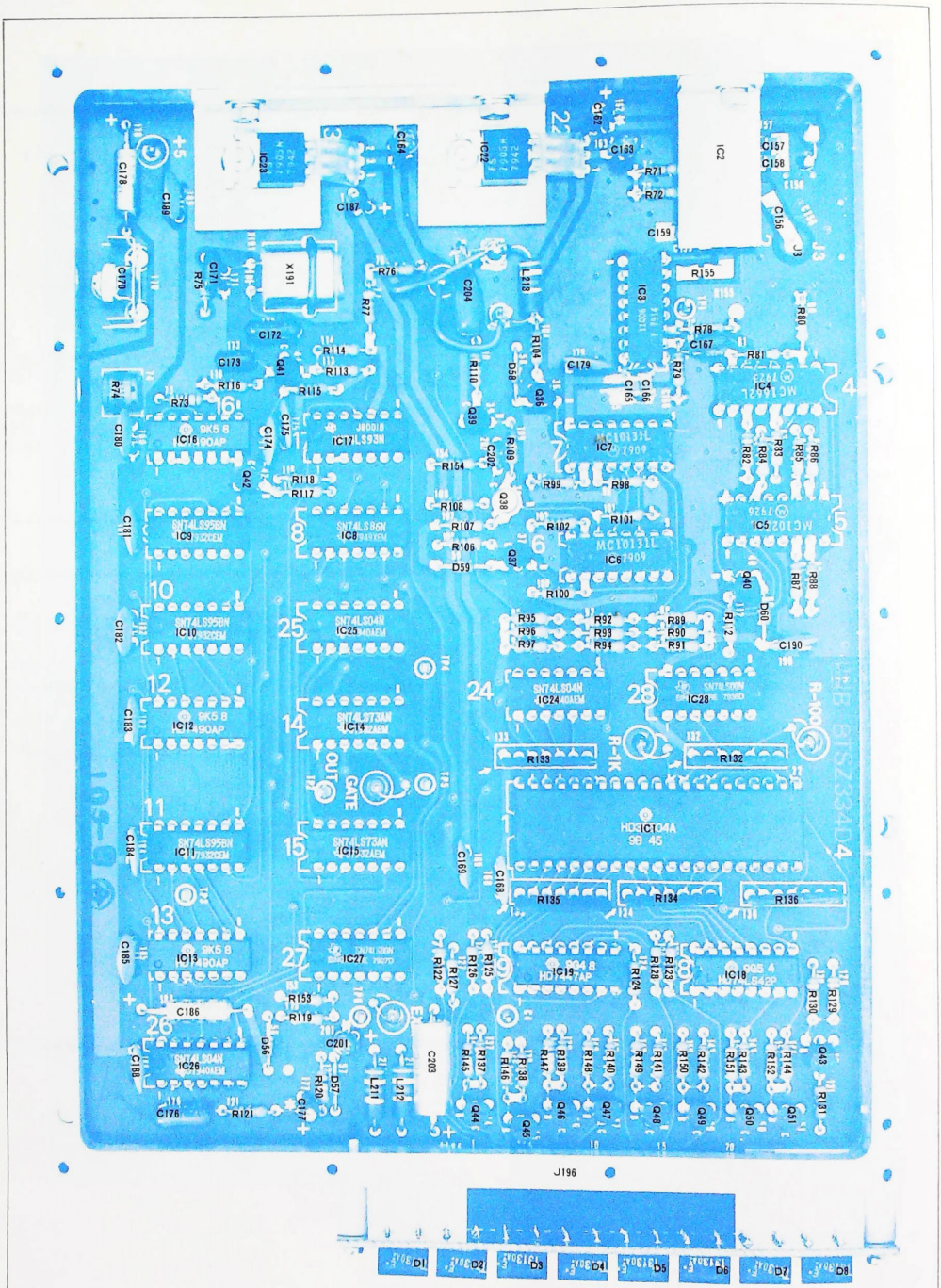
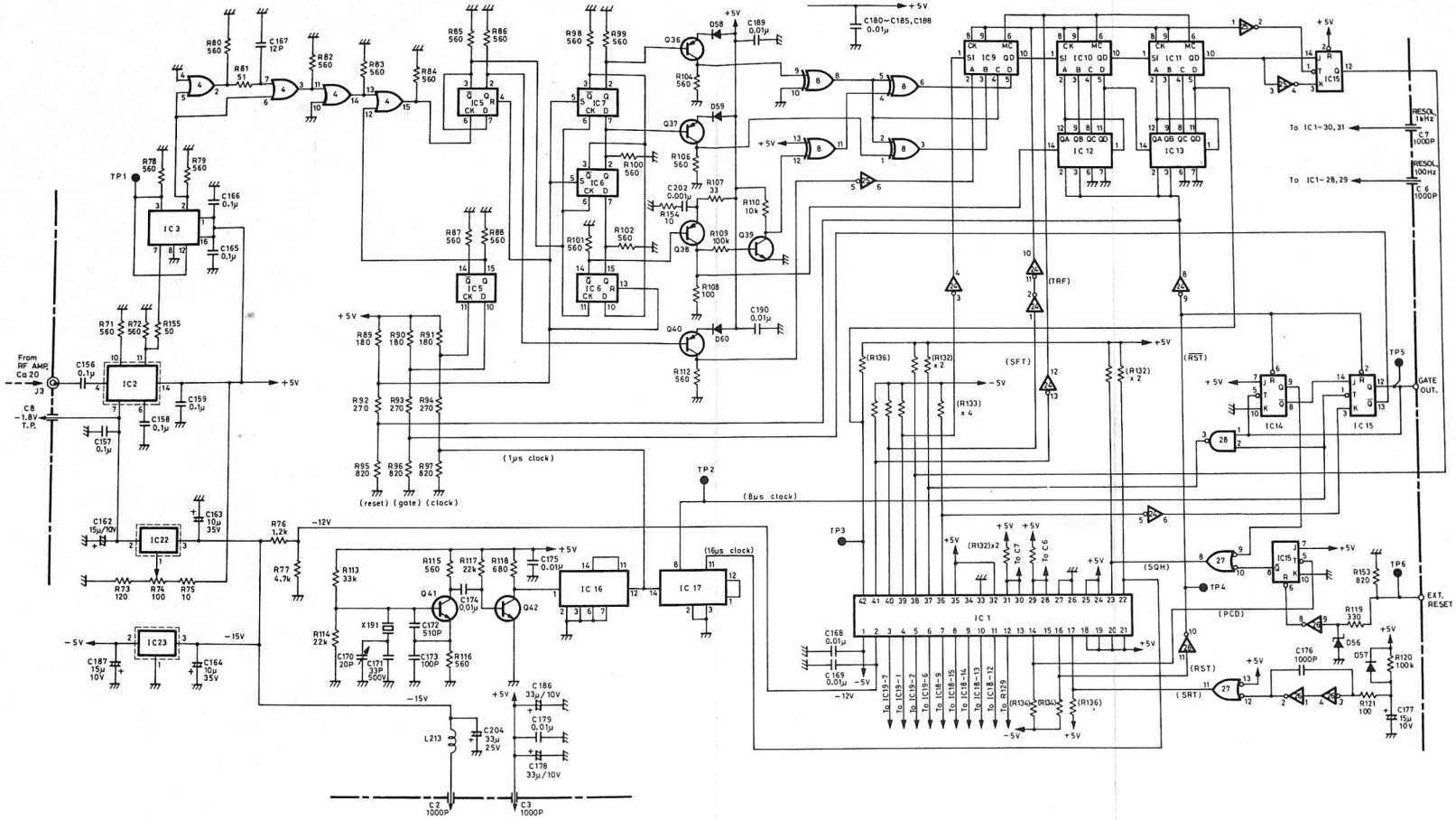


Fig. 8 – 12 Locations & Diagrams, MEP-260 (FREQUENCY COUNTER)



TR -TR-4122B

FREQUENCY COUNTER (MEP-260) 1/4

SZ334 COUNTER LOGIC 1/2

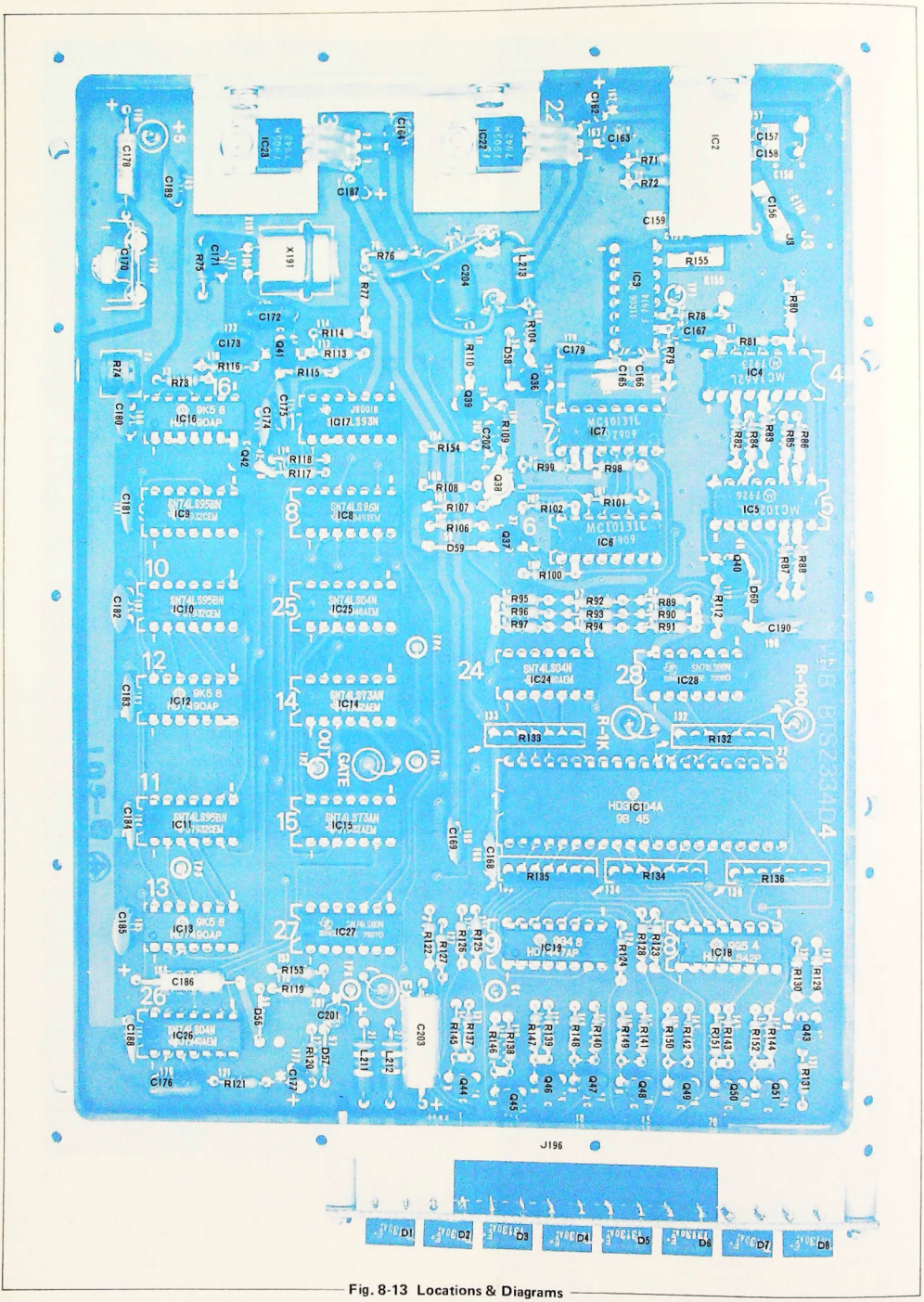
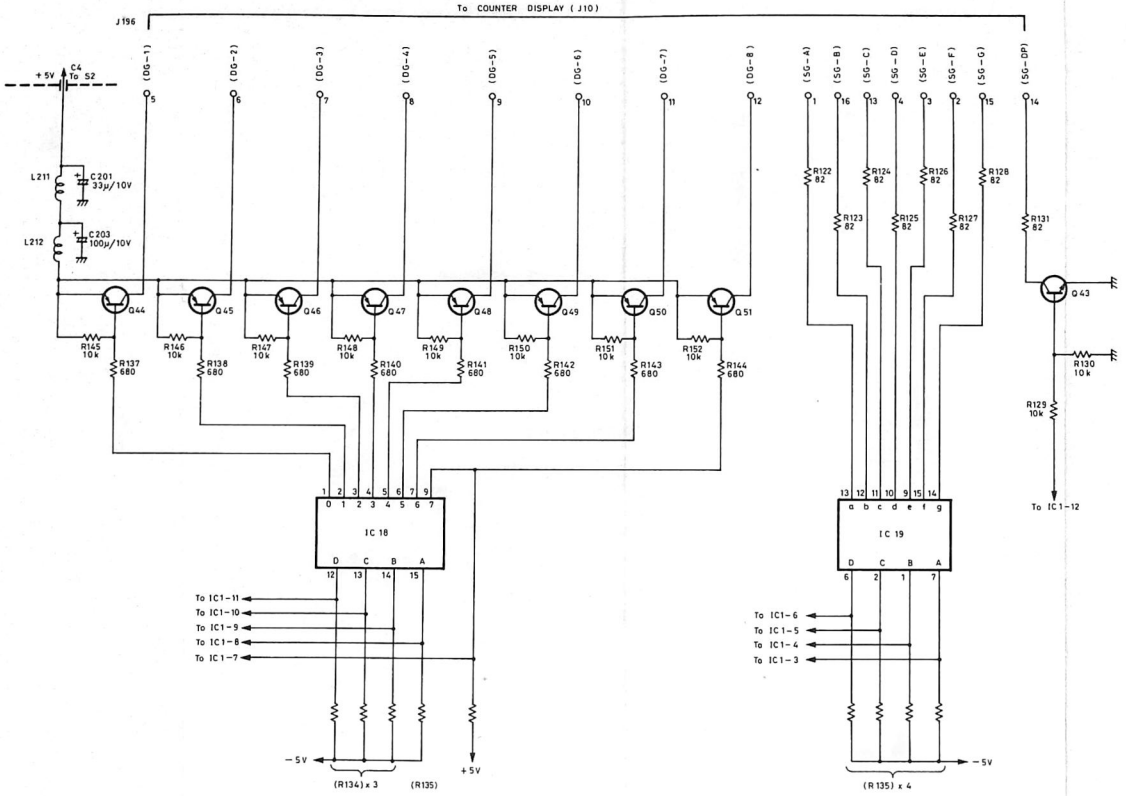


Fig. 8-13 Locations & Diagrams



-TR-4122B

FREQUENCY COUNTER (MEP-260) 2/4

SZ334 COUNTER LOGIC 2/2

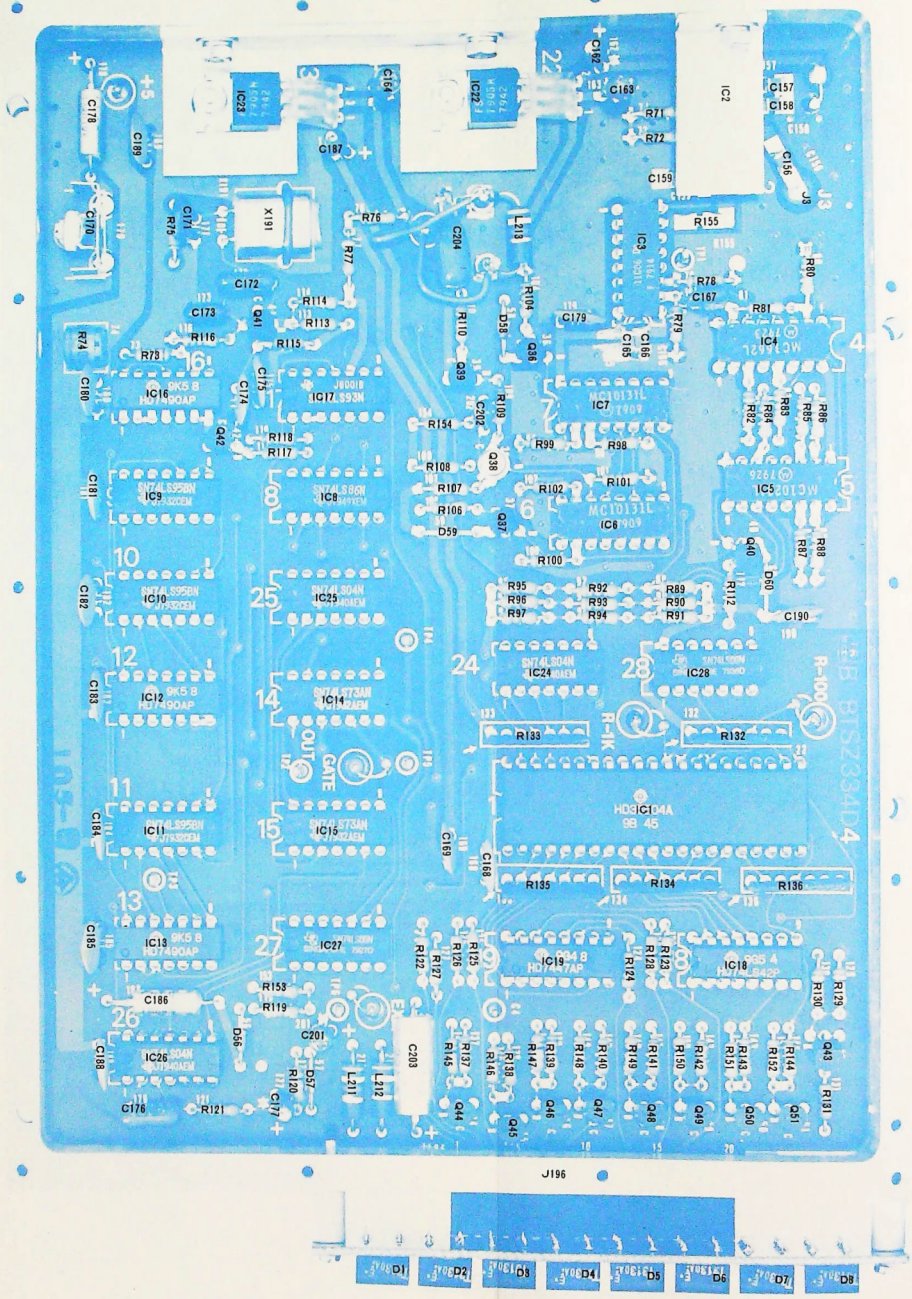
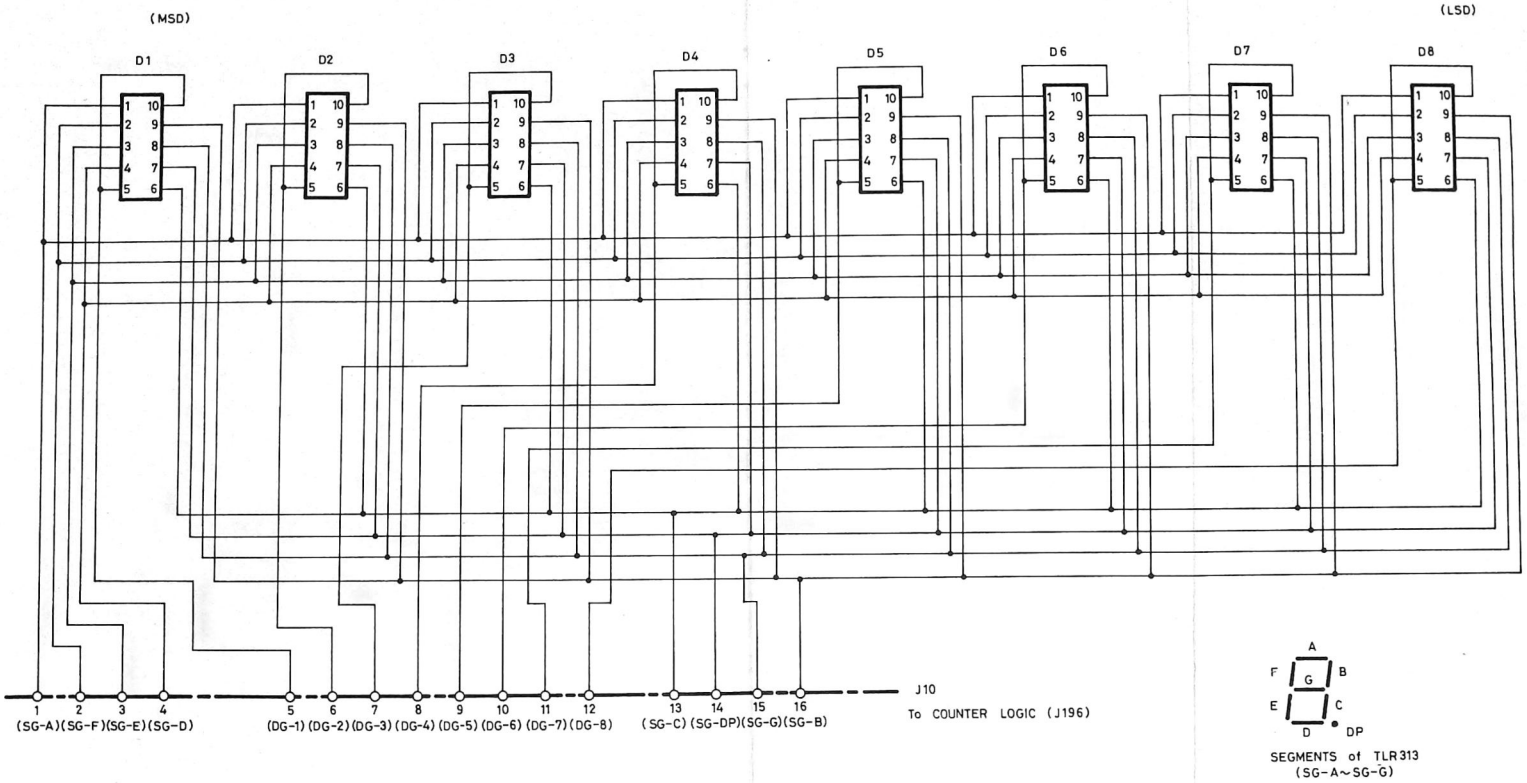


Fig. 8 – 14 Locations & Diagrams, SG175 (COUNTER DISPLAY)



0995006-014-A

-TR-4122B
FREQUENCY COUNTER (MEP-260) 3/4
SG175 COUNTER DISPLAY

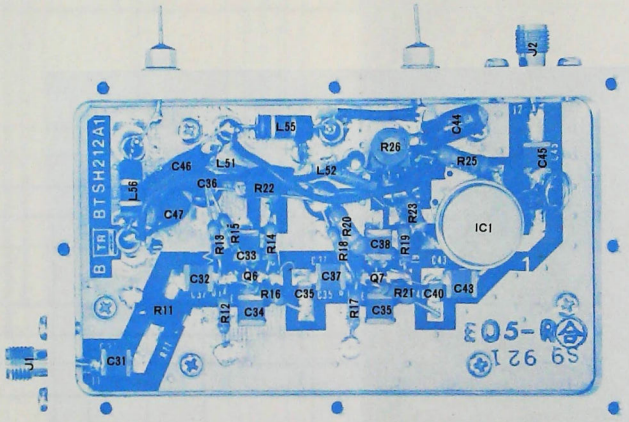
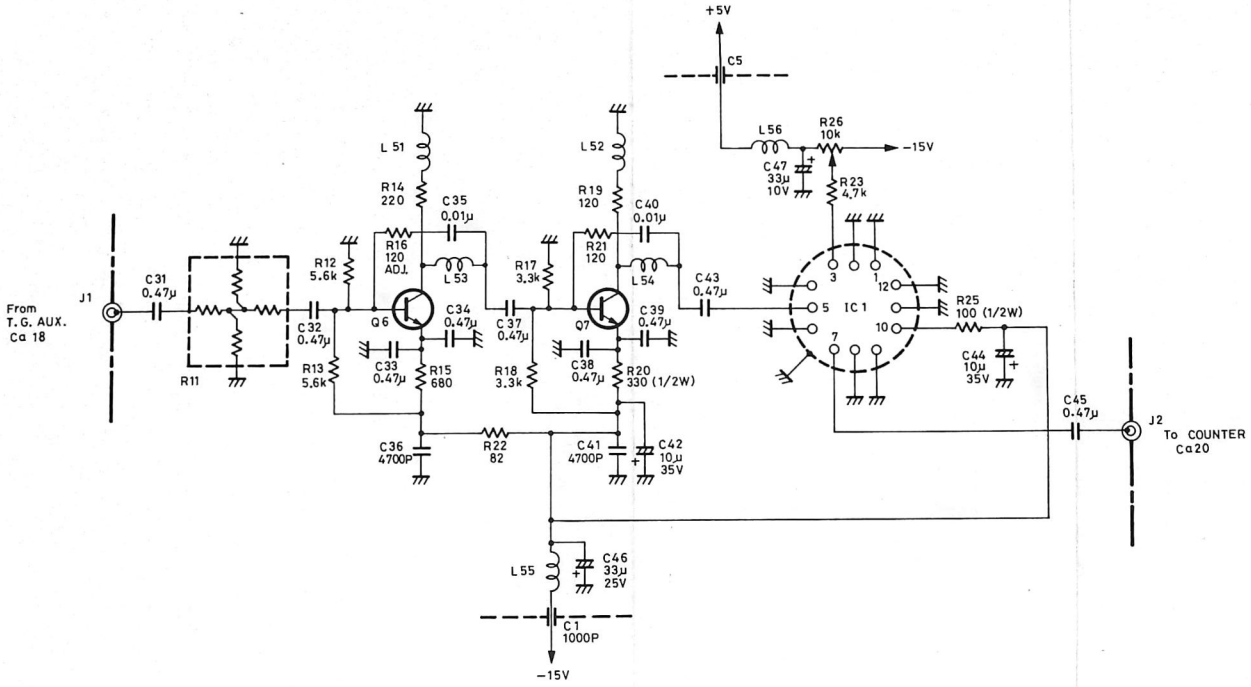


Fig. 8 – 15 Locations & Diagrams, SH212 (COUNTER RF AMP.)



-TR-4122B
FREQUENCY COUNTER (MEP-260) 4/4
SH212 COUNTER RF AMP.

0995006-015-A

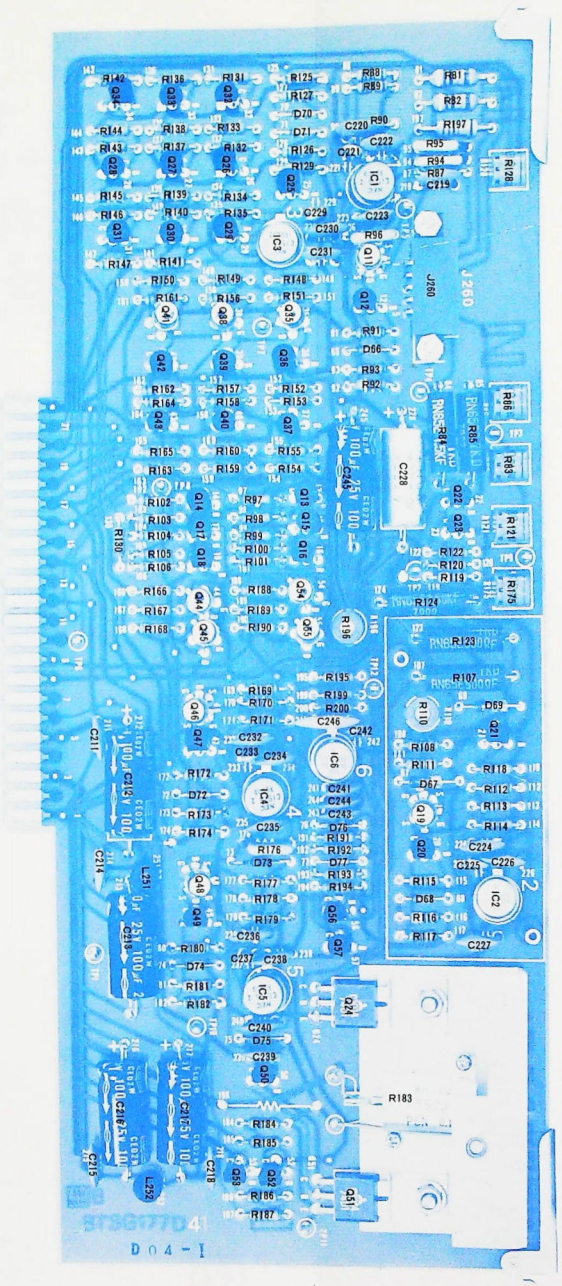
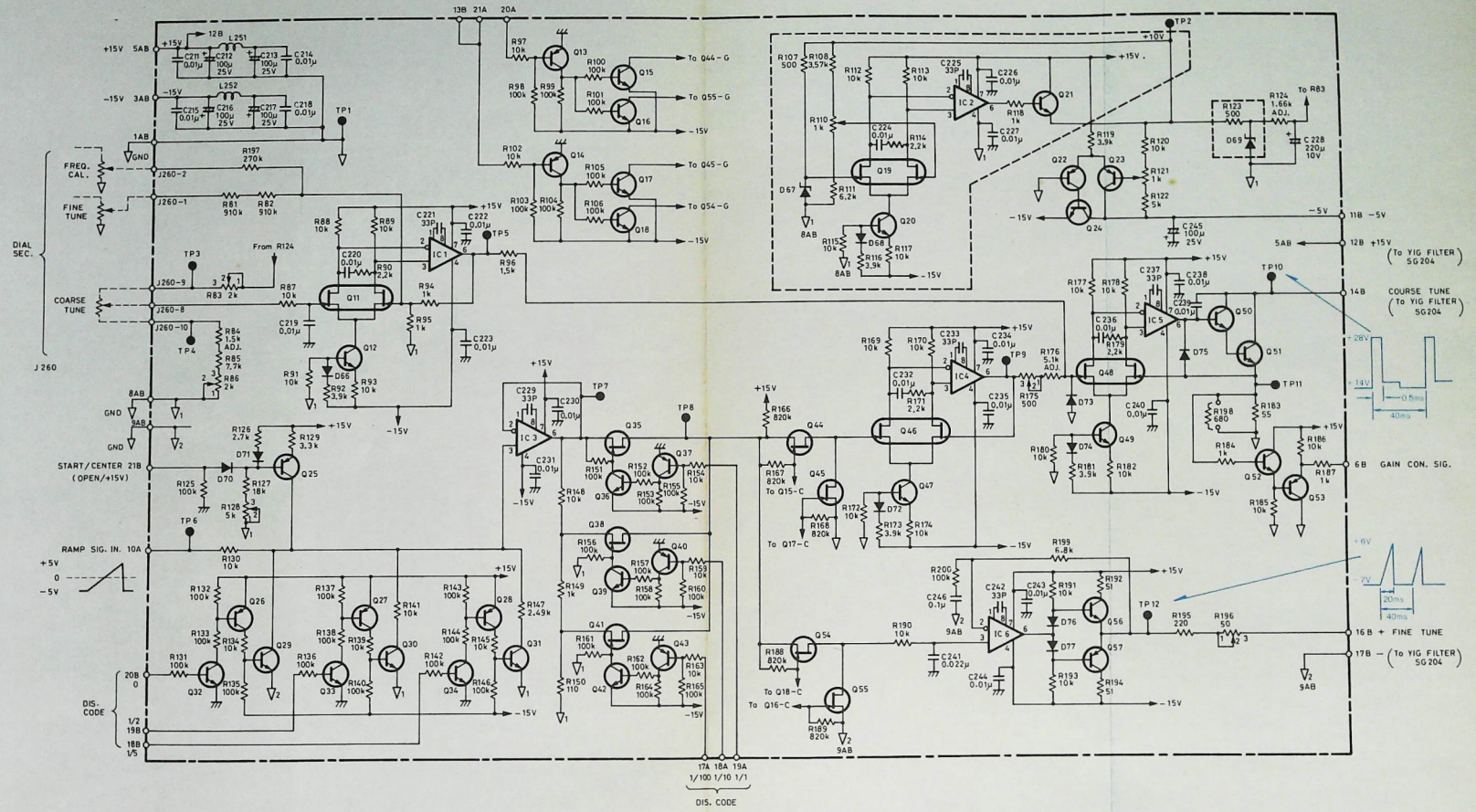


Fig. 8 – 16 Locations & Diagrams, PG177 (YIG DRIVER)



-TR-4122B
YIG DRIVER
PG177

0995006-016-A

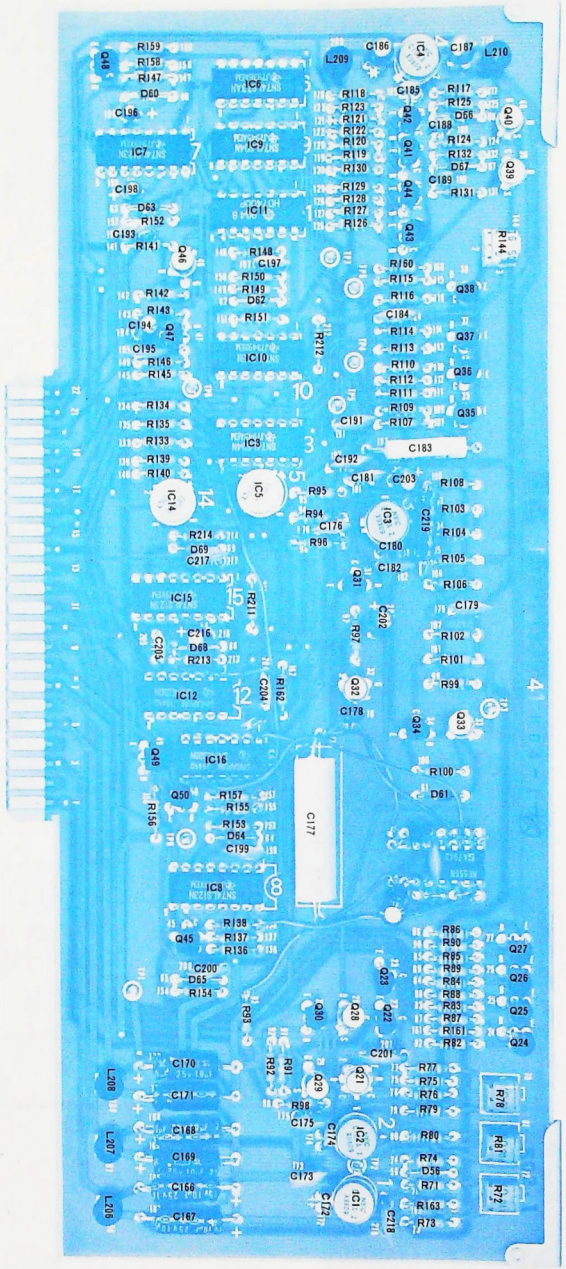
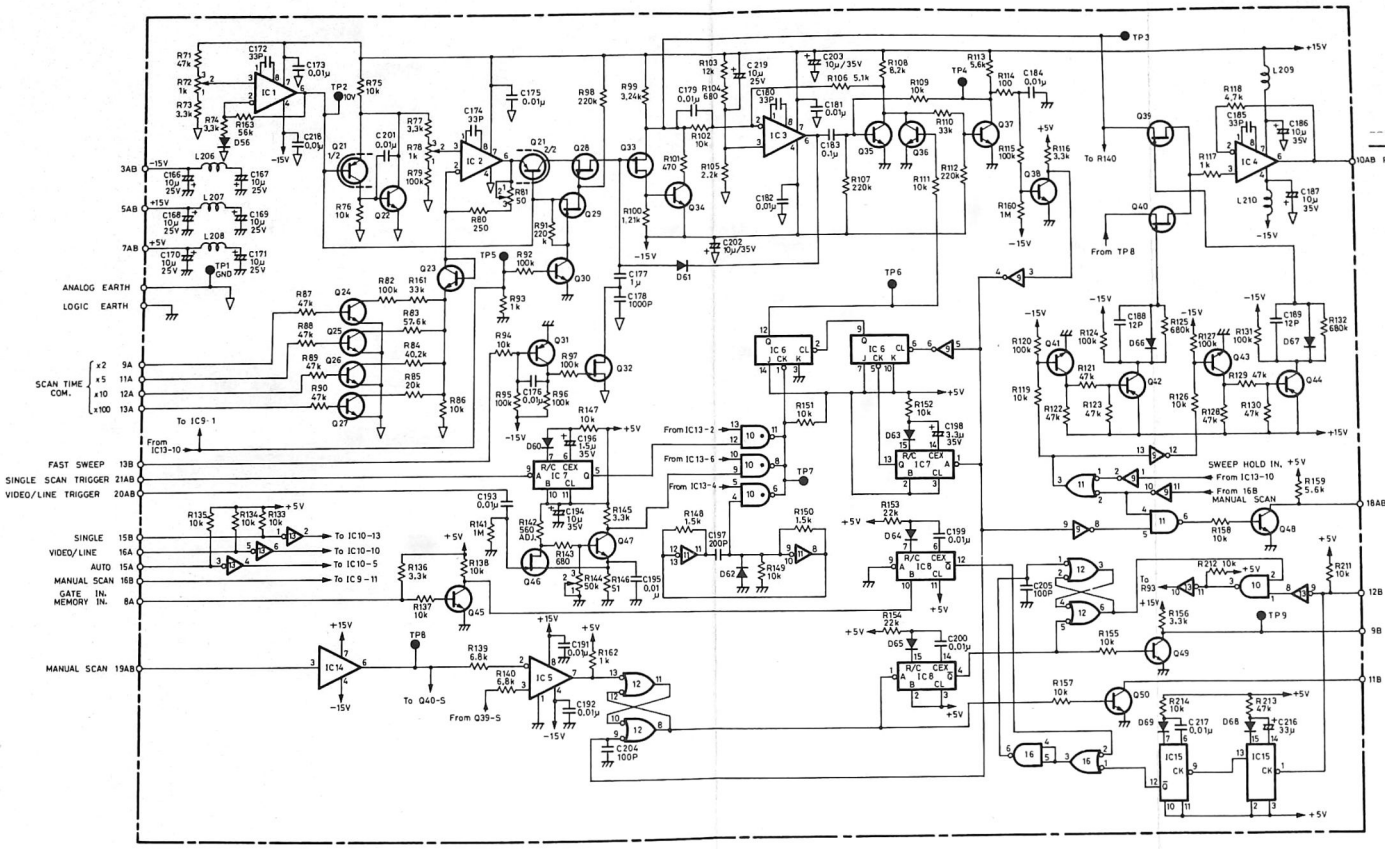


Fig. 8 – 17 Locations & Diagrams, PF119 (RAMP GENERATOR)



-TR-4122B
RAMP GENERATOR
PF119

0995006-017-A

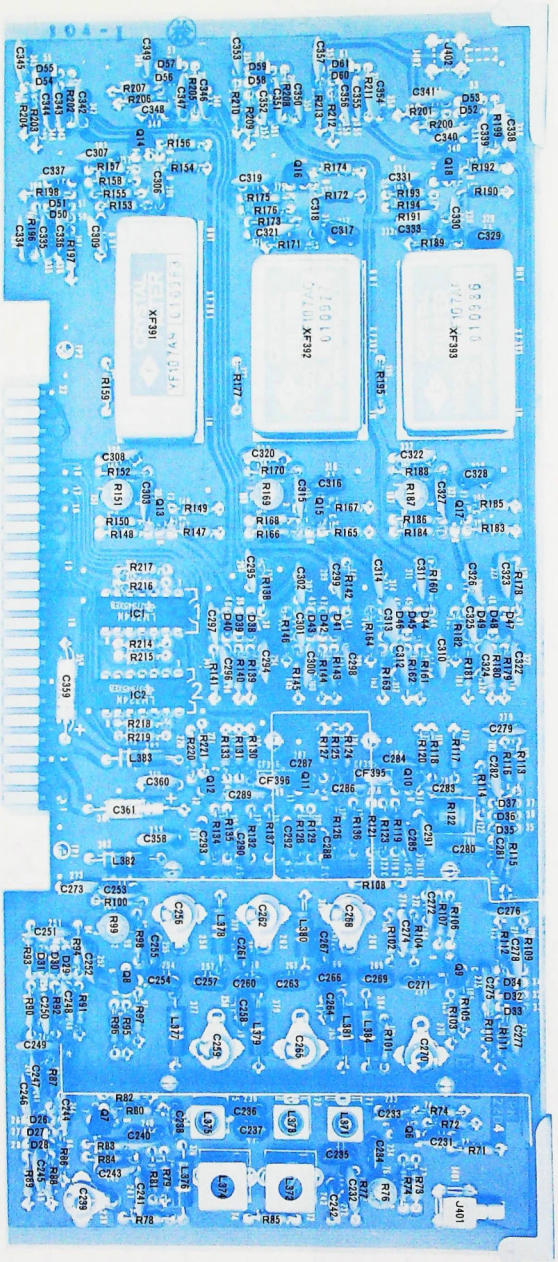
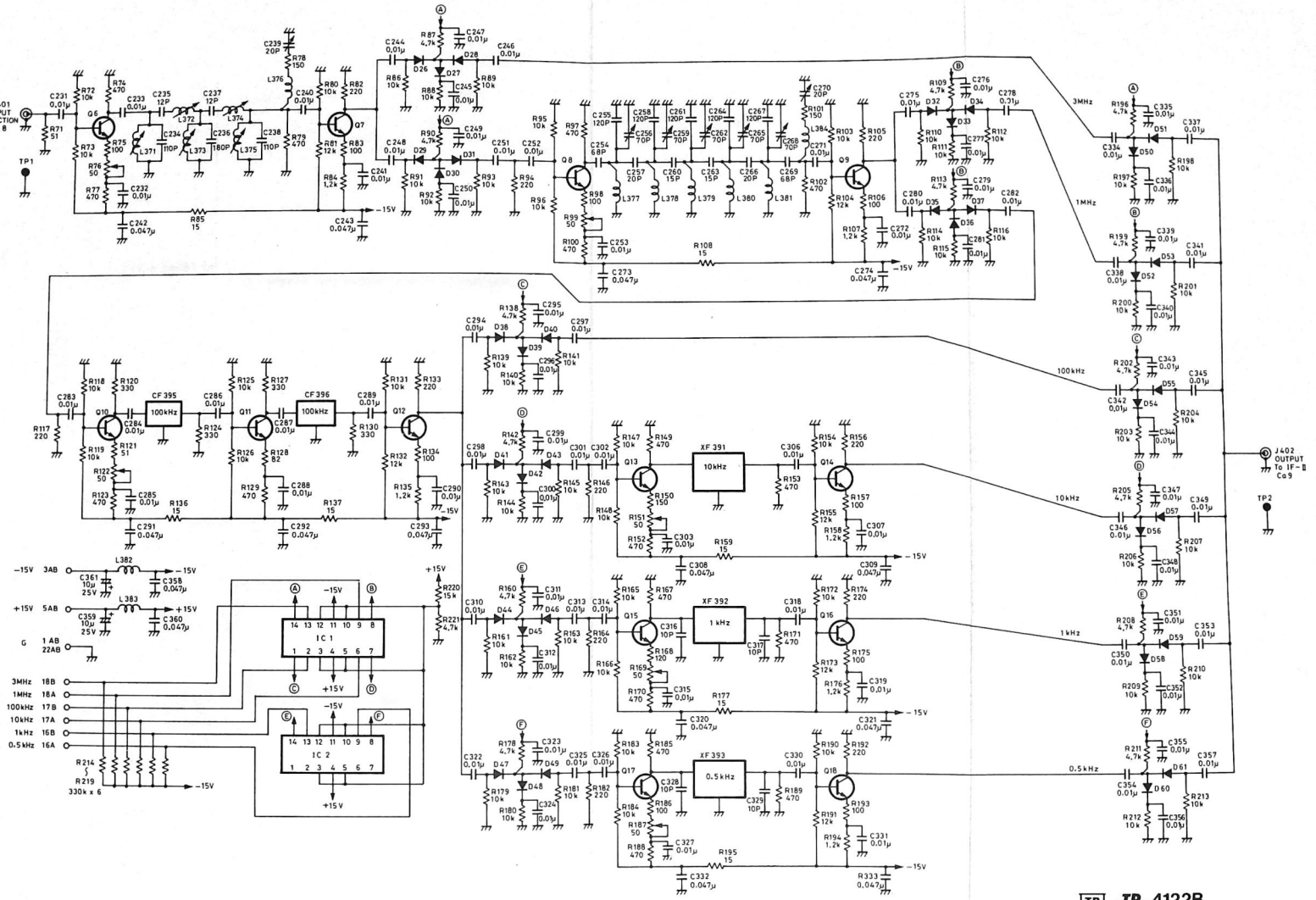


Fig. 8 – 18 Locations & Diagrams, PK022 (IF-I)



0995006-018-A

-TR-4122B
IF-I
PK022

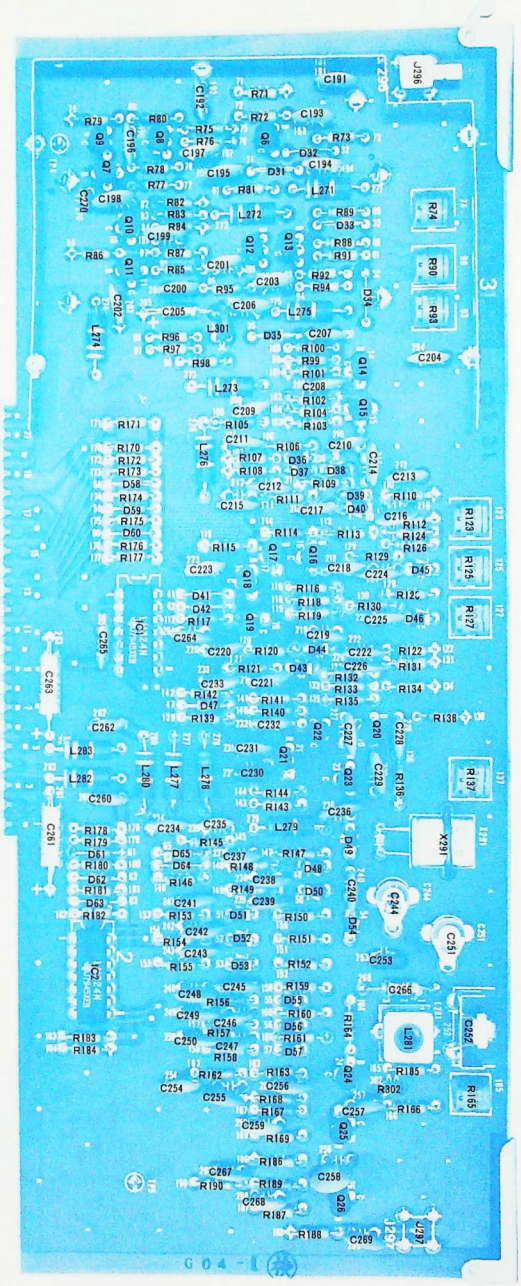
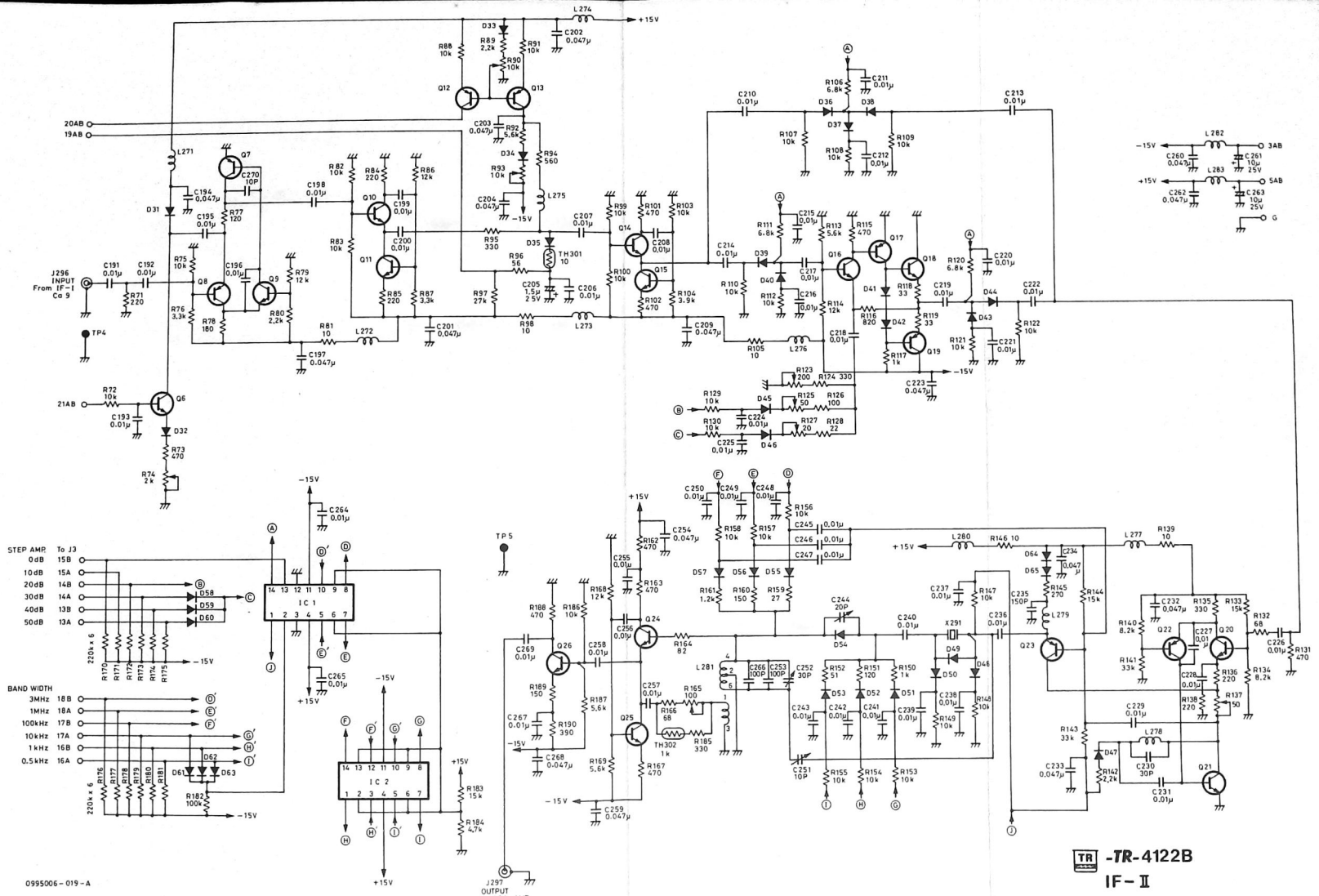


Fig. 8 – 19 Locations & Diagrams, PK026 (IF-II)


-TR-4122B
IF-II
PK026
0995006-019-A
STEP AMP
BAND WIDTH
IC 1
IC 2
J296 INPUT From IF-I Cn 9
J297 OUTPUT To LOG. AMP. Cn10
TP4
TP5
20AB
19AB
21AB
3AB
5AB
G
+15V
-15V

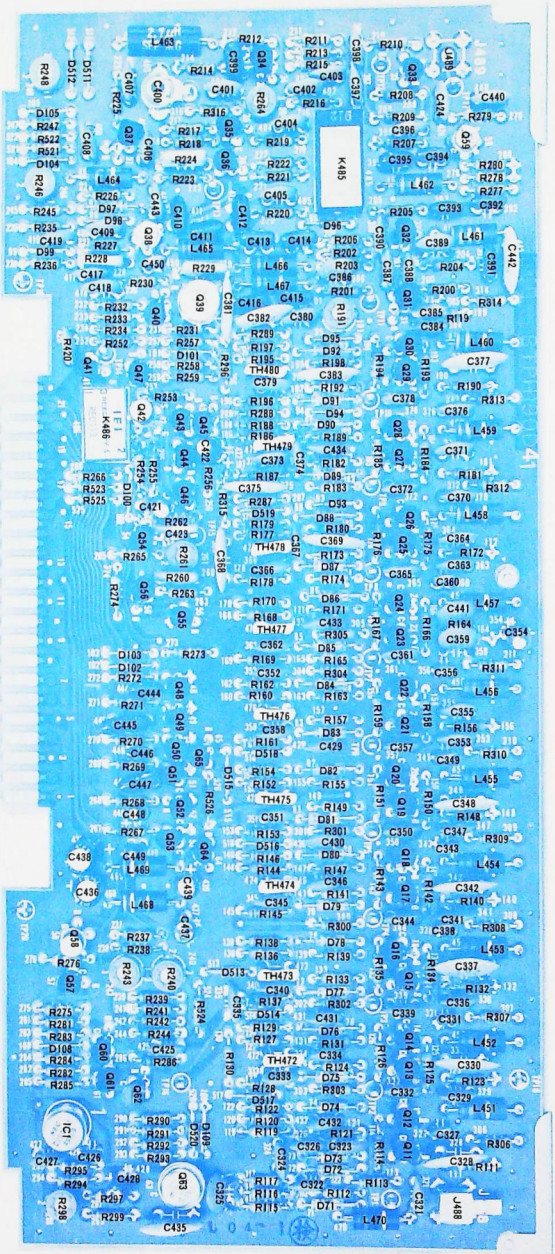
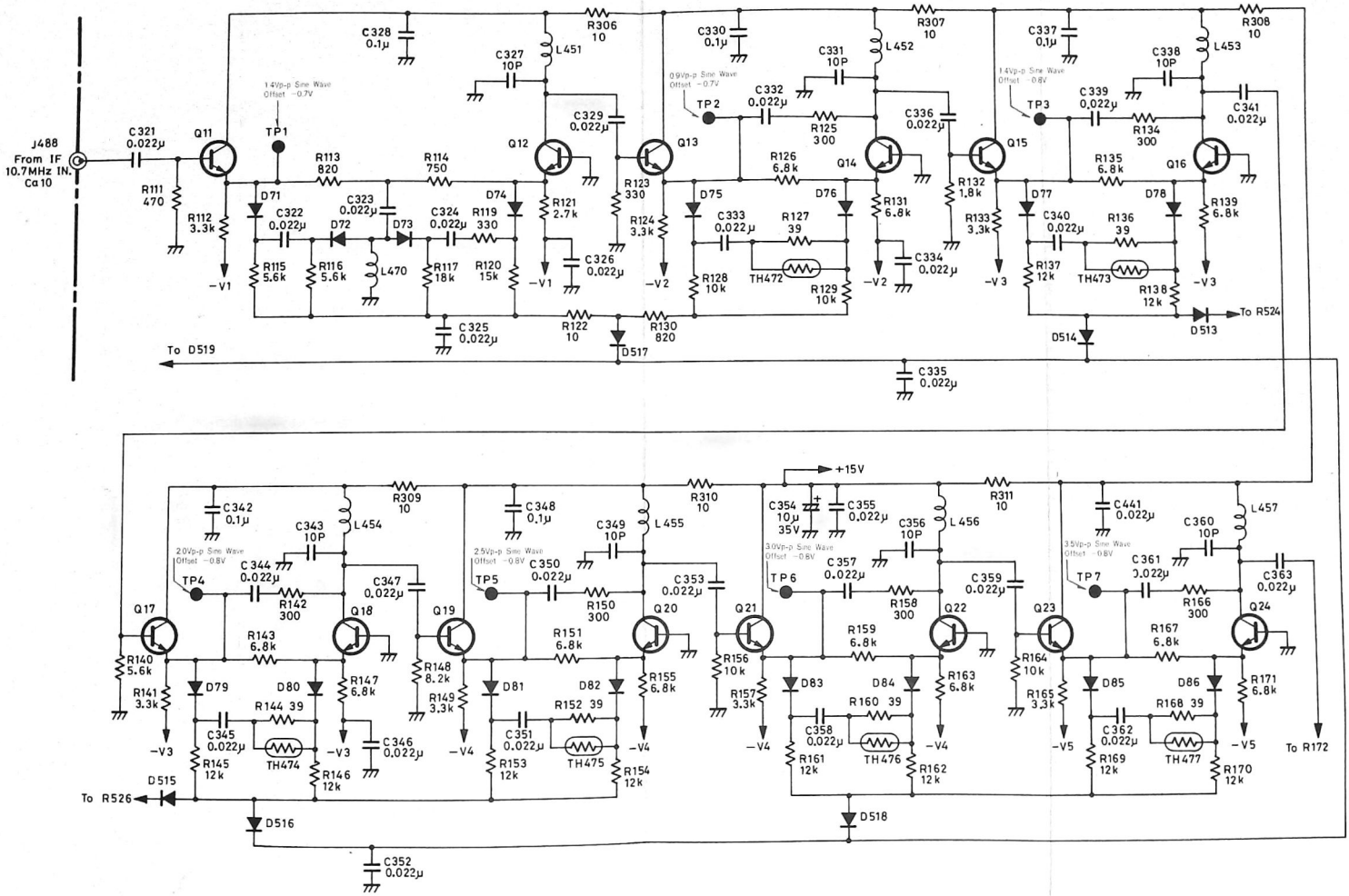


Fig. 8 – 20 Locations & Diagrams, PH190 (LOG. AMP.)



TR -TR- 4122B
LOG. AMP. 1/3
PH190

0995006 - 020 - A

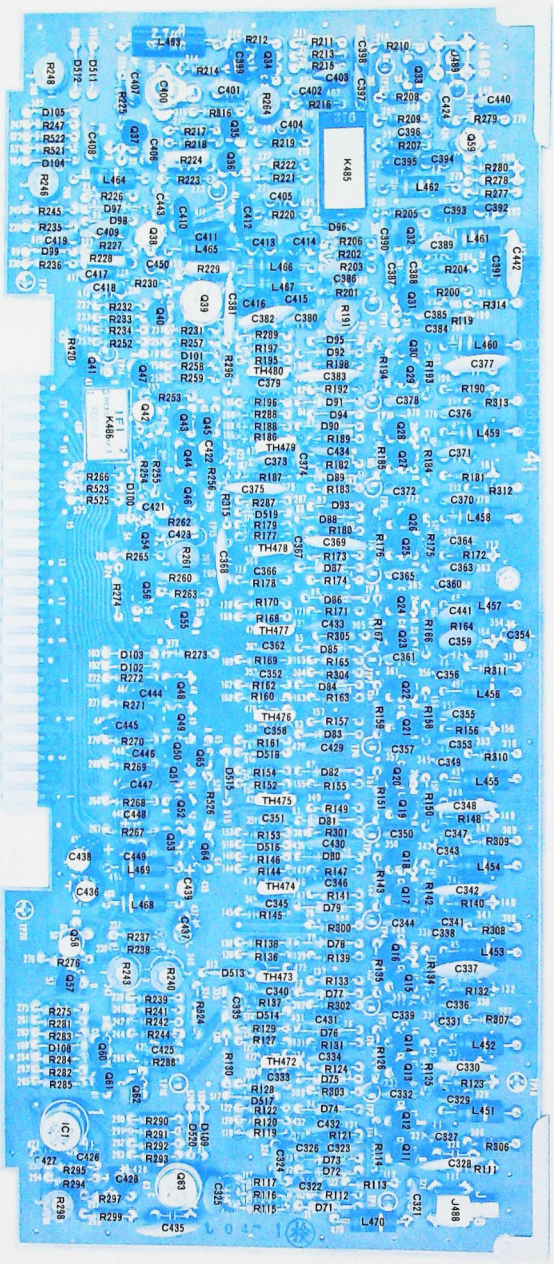
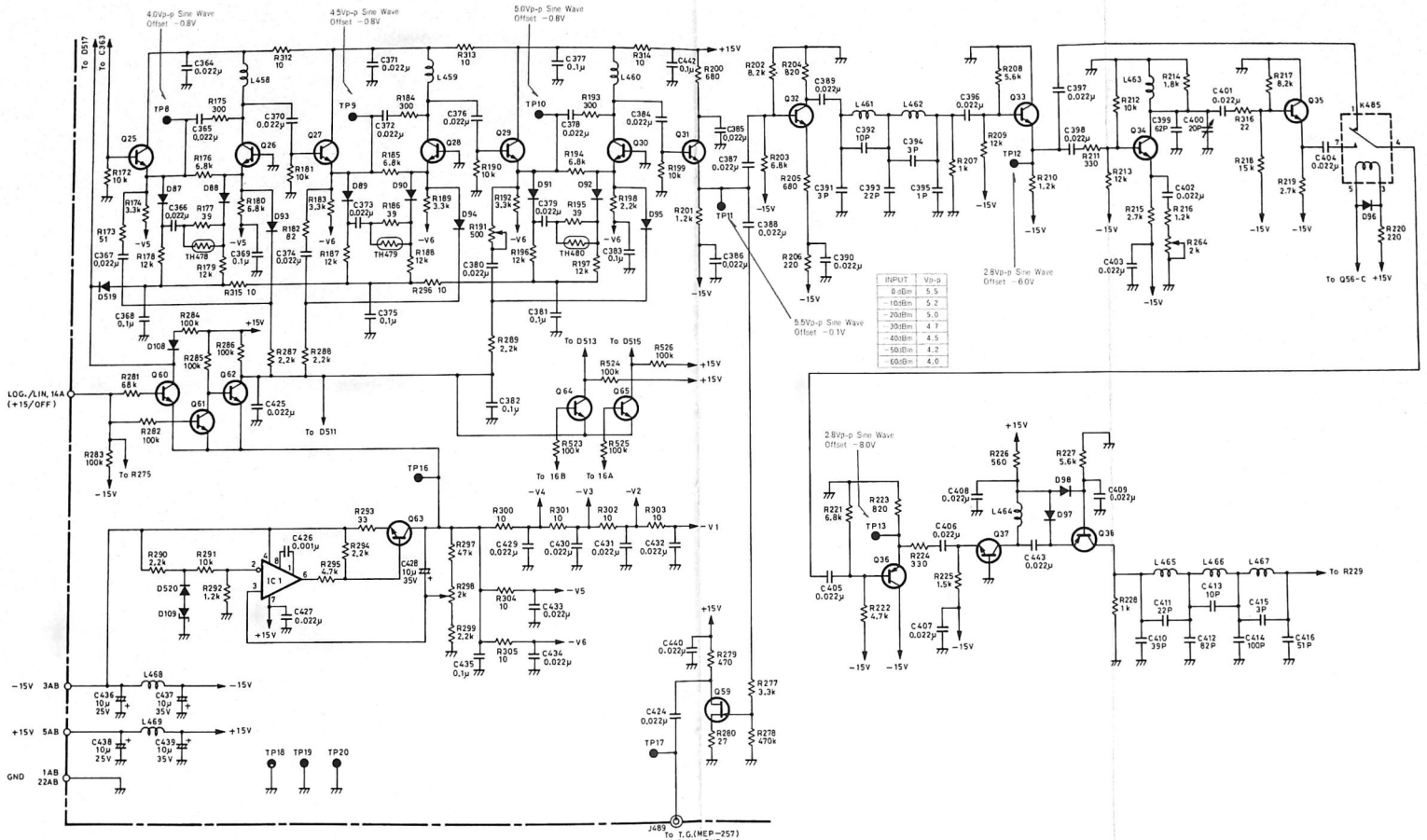


Fig. 8 – 21 Locations & Diagrams, PH190 (LOG. AMP.)



-TR-4122B
LOG. AMP. 2/3
PH190

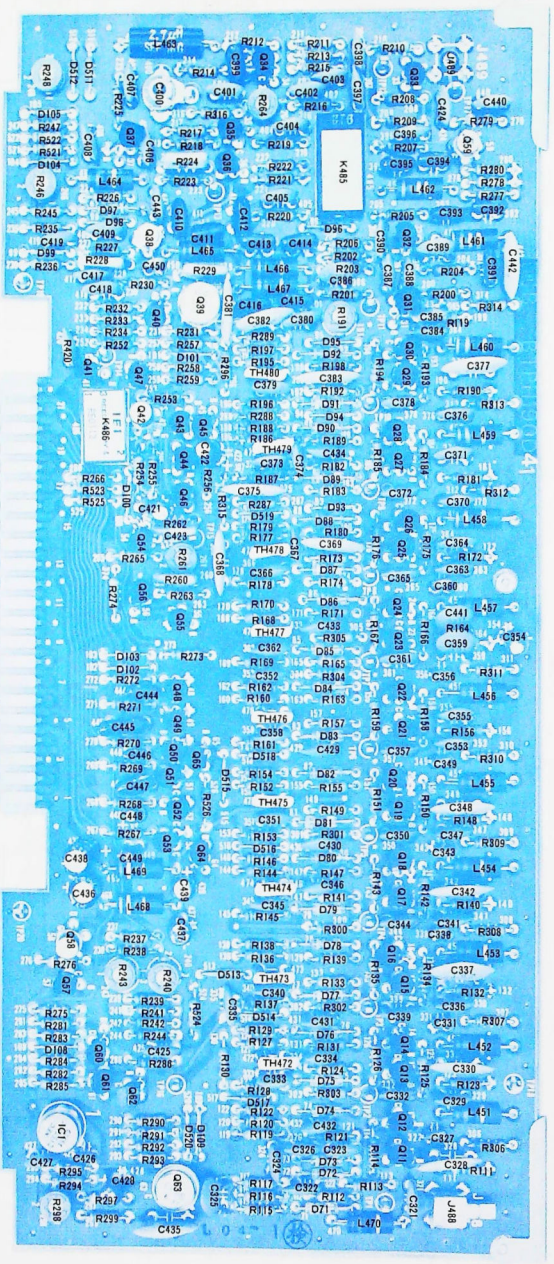
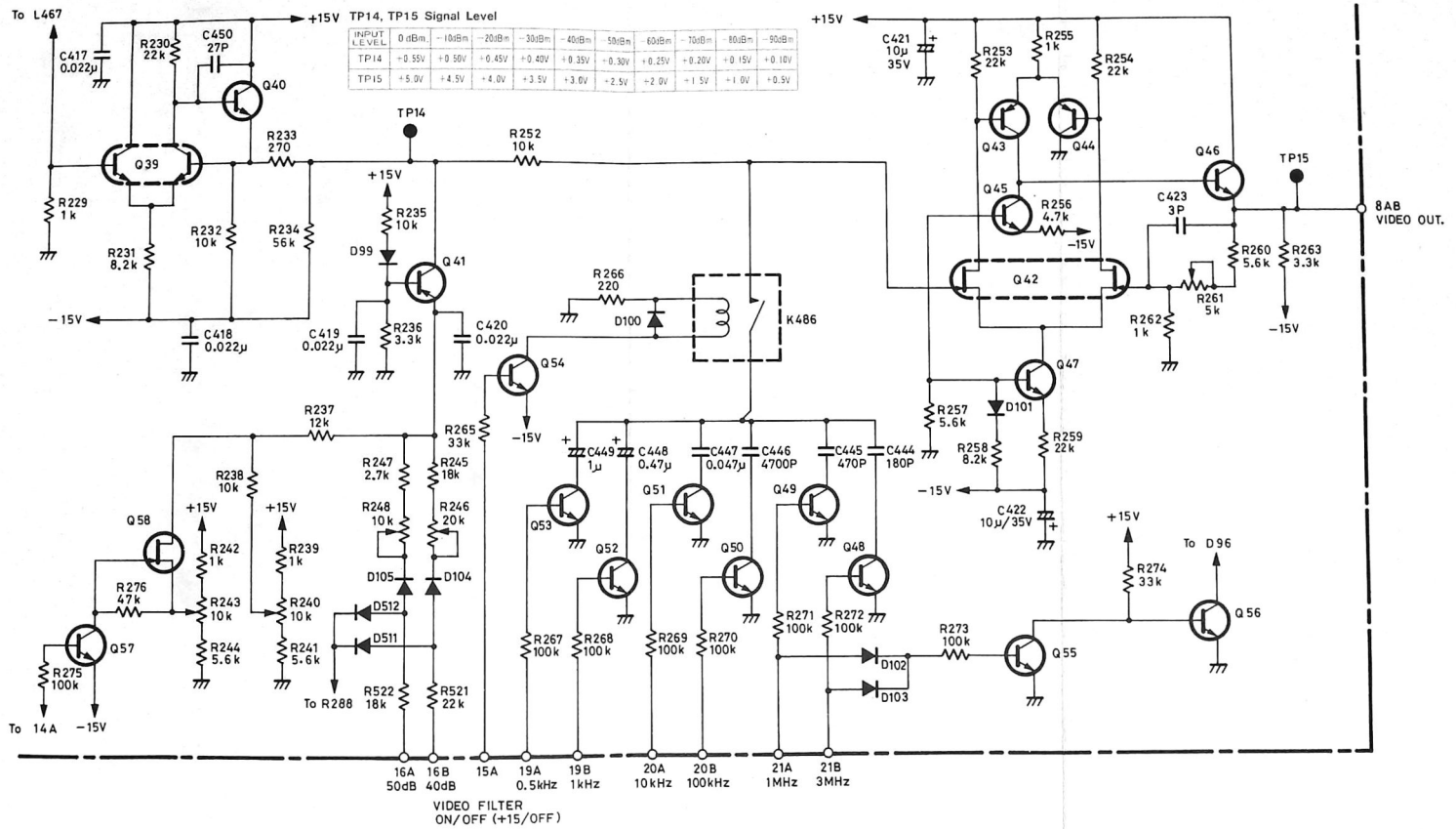


Fig. 8 – 22 Locations & Diagrams, PH190 (LOG. AMP.)



0995006-022-A

TR -TR-4122B
LOG. AMP. 3/3
PH190

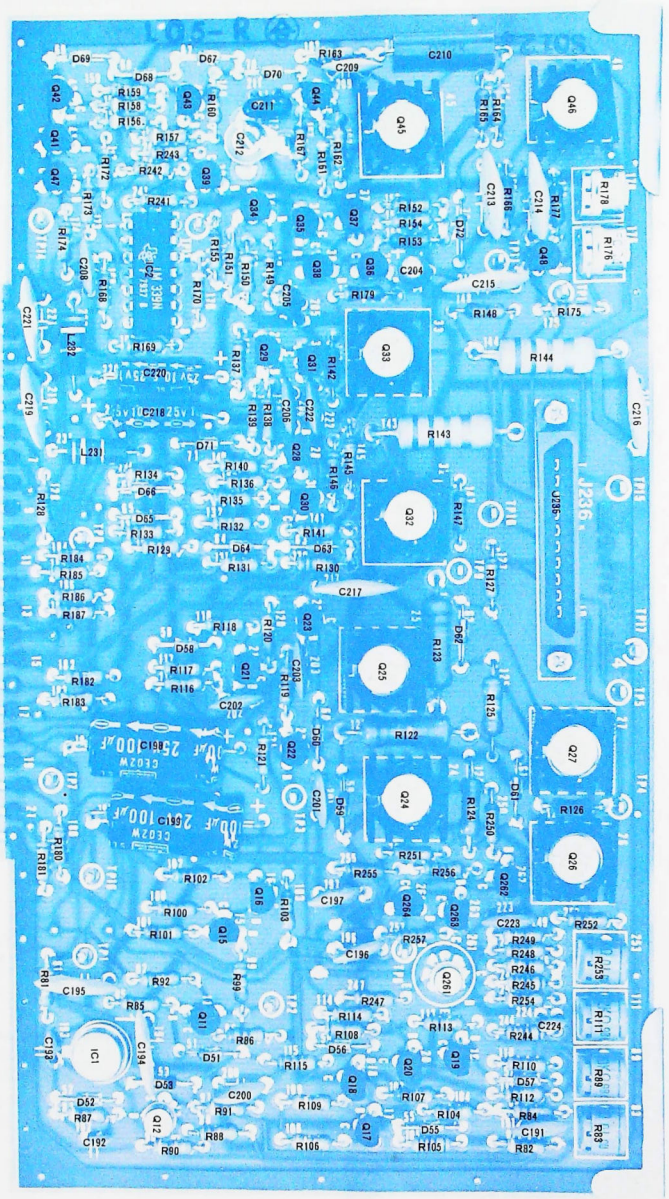
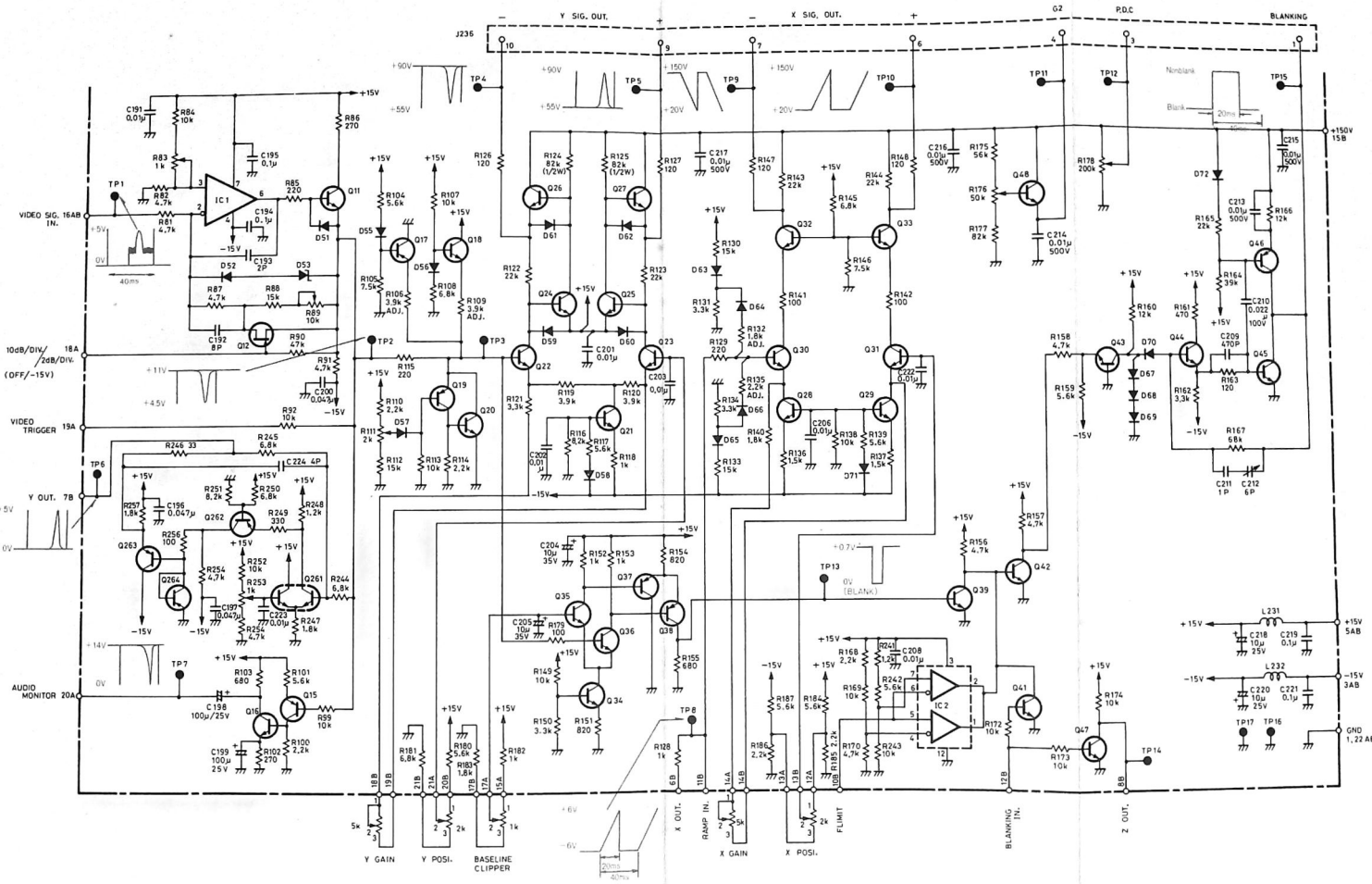
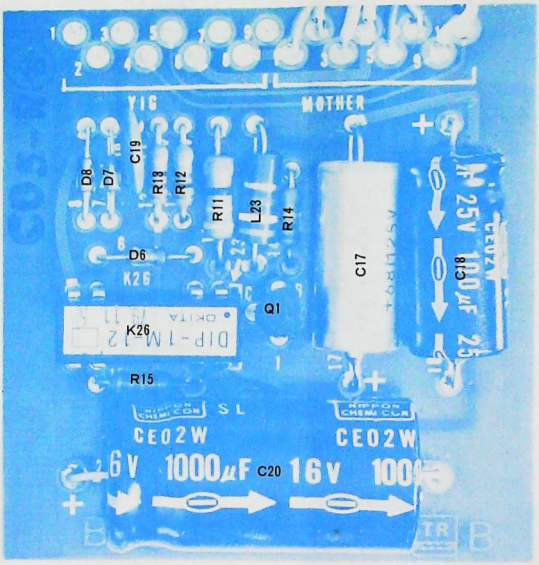


Fig. 8 – 23 Locations & Diagrams, SG178 (CRT DRIVER)



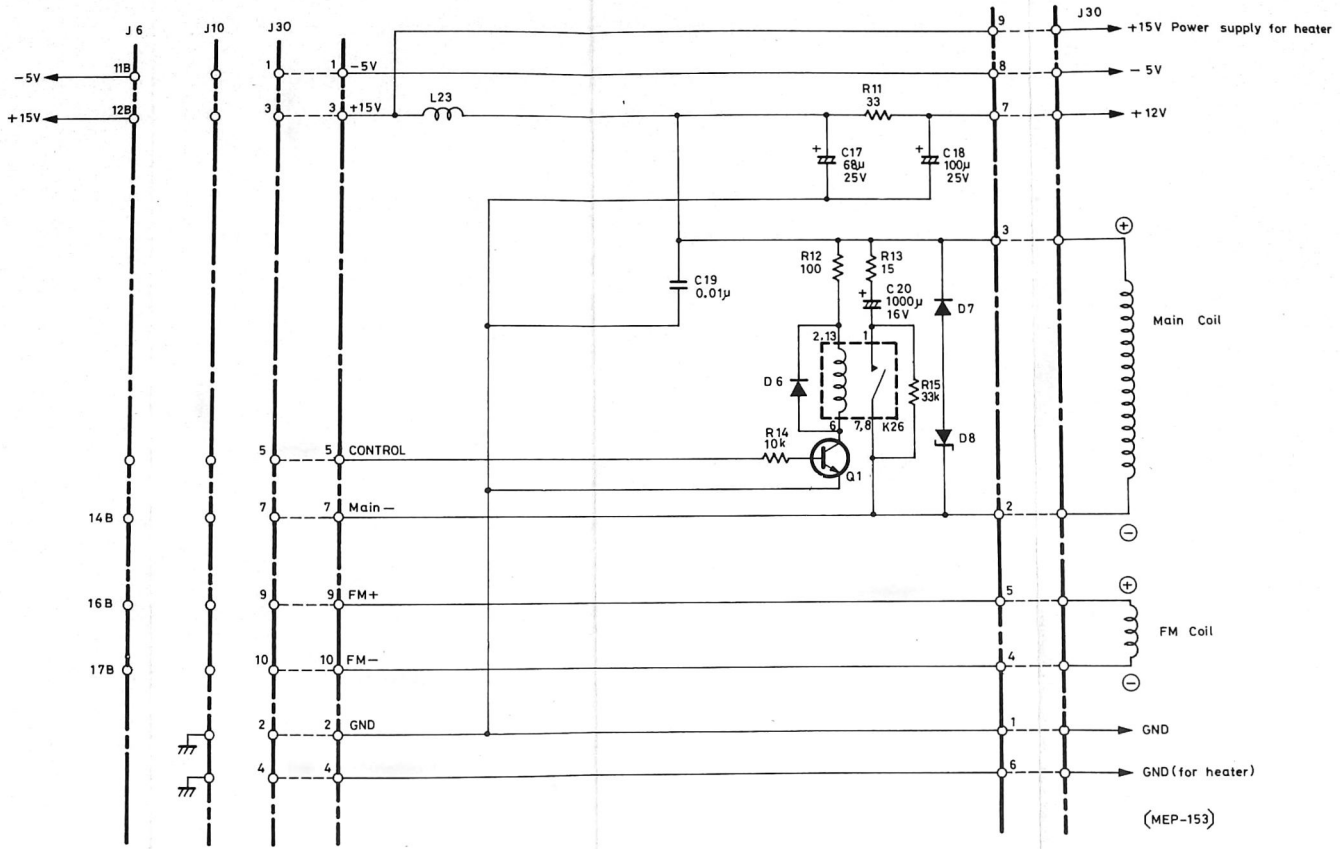
-TR-4122B
CRT DRIVER
SG178

0995006-023-A

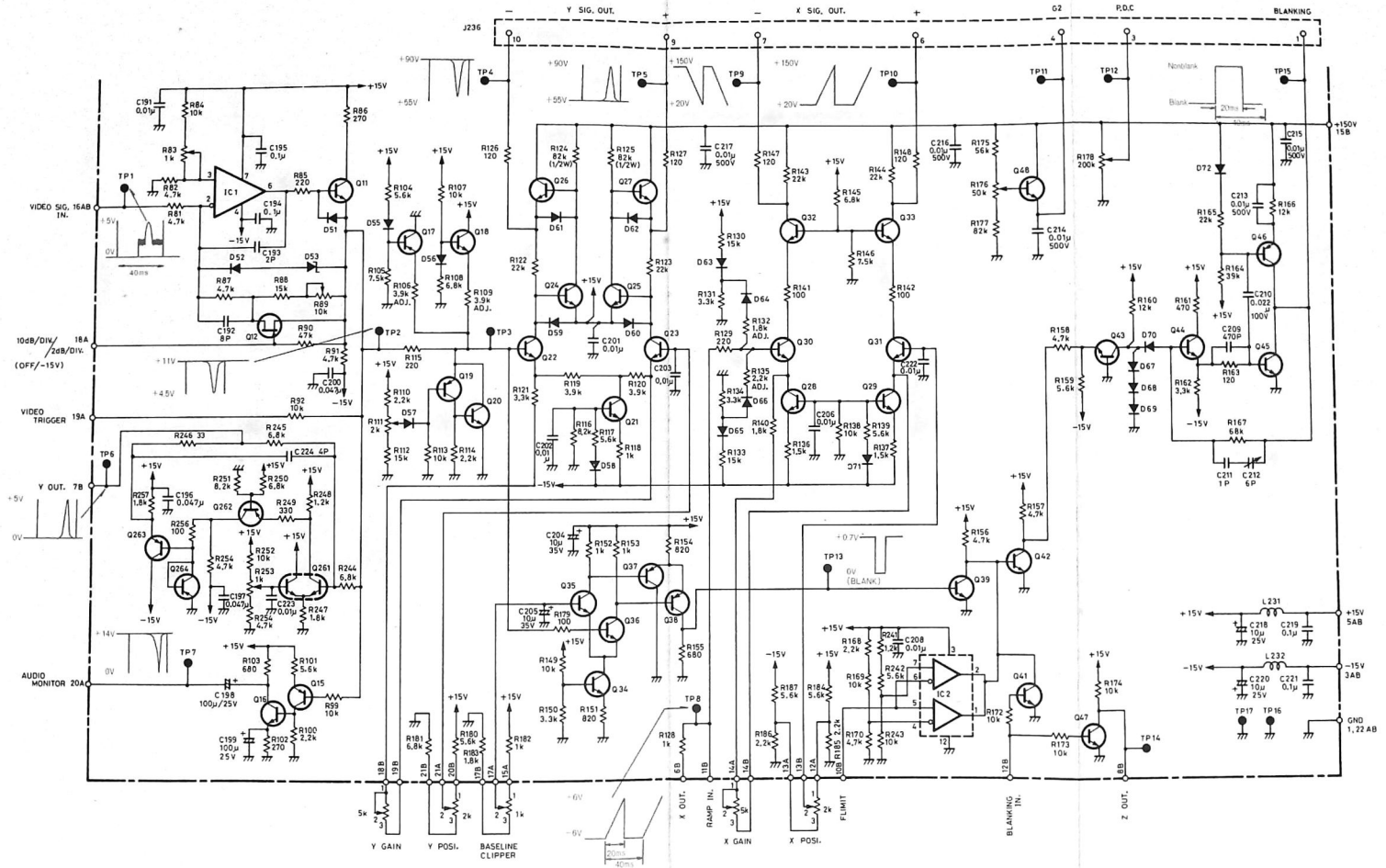


TOP-1200 YIG TUNED OSC.

Fig. 8 – 24 YIG Tuned OSC. & Locations SG204 (YIG POWER SUPPLY)



TR -TR-4122B
YIG POWER SUPPLY & FILTER
SG204



-TR-4122B
CRT DRIVER
SG178

Fig. & INDEX No.		Stock No.	Description	
8-1	1	MXB-0354-0155-1	CABINET, bottom	
	2	782-6081	FOOT	
	3	452-9003	STAND	
	4	562-0006A	NUT, for foot	
	5	K-2017	FOOT, rubber	
	6	MXB-0353-2155-1	CABINET, top	

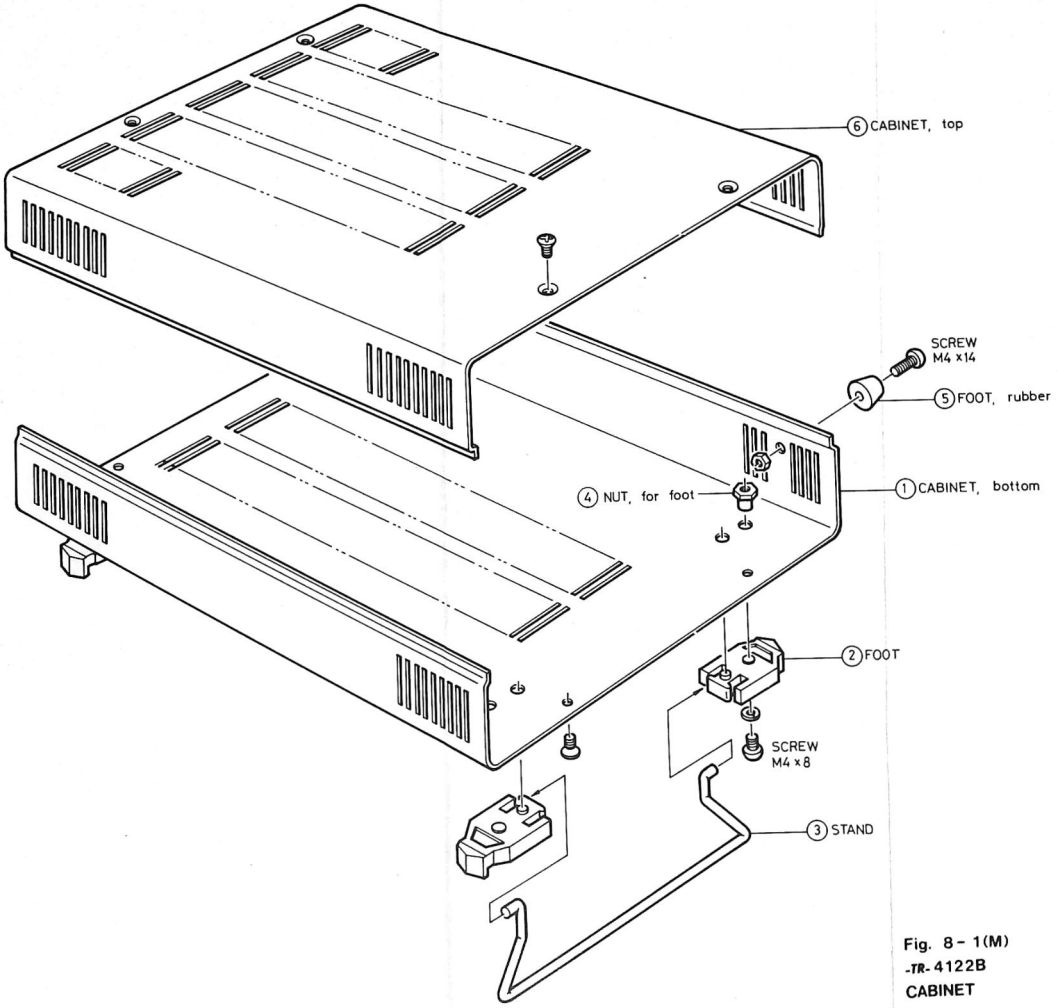
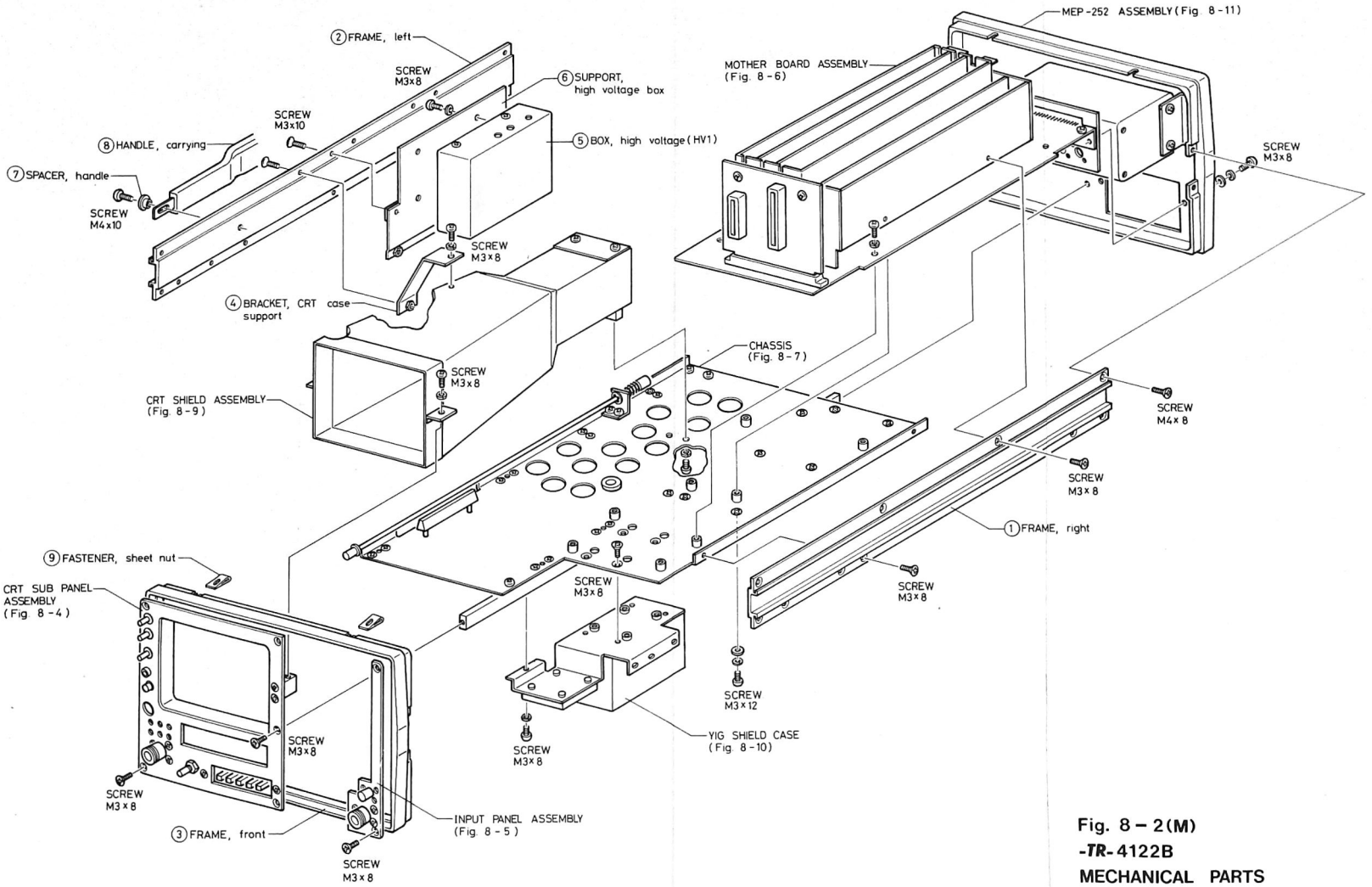


Fig. 8 - 1(M)
-TR-4122B
CABINET

Fig. & INDEX No.		Stock No.	Description	
8-2	1	MTK-0108-0185-6	FRAME, right	
	2	MTK-0109-0185-4	FRAME, left	
	3	MEC-0006-0105-3	FRAME, front	
	4	MIB-0366-0103-6	BRACKET, CRT case support	
	5	MTM-5562	BOX, high voltage (HV1)	
	6	MIB-0361-0134-0	SUPPORT, high voltage box	
	7	592-5210	SPACER, handle	
	8	782-5451	HANDLE, carrying	
	9	USN-00905-A	FASTENER, Sheet nut	


MEP-252 ASSEMBLY (Fig. 8-11)
MOTHER BOARD ASSEMBLY (Fig. 8-6)
SCREW M3x8
SCREW M4x8
SCREW M3x8
SCREW M4x8
SCREW M3x8
SCREW M3x8
SCREW M3x12
SCREW M3x8
SCREW M3x8
SCREW M3x8
SCREW M3x8
SCREW M3x8
SCREW M3x10
SCREW M4x10
SCREW M3x8
SCREW M3x8
SCREW M3x8
SCREW M3x8
SCREW M3x8

MECHANICAL PARTS LIST
FRONT & MEP-251 ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-3	1	MIB-0358-0134-6	PLATE, sub-panel	
	2	LS19P 1-2-4D	SWITCH, SCAN TRIG. (S5)	
	3	LS19P 1-3-3D	SWITCH, VERT. MODE (S4)	
	4	MSP 103C	SWITCH, push SINGLE SCAN (S7)	
	5	10-4	CONNECTOR, PHONE	
	6	入-13B-2kΩ	Wirewound Potentiometer, ADJ (R3)	
	7	RA25YN25SB10kΩG	RESISTOR, variable FINE (R2)	
	8	MFS-201N6	SWITCH, VIDEO FILTER (S3)	
	9	MFS-201N6	SWITCH, START/CENTER (S1)	
	10	SL83	SWITCH, SCAN MODE (S6)	
	11	MXK-0106-0182-4	STOPPER, board PB296	
	12	MEG-0025-2103-7	TUNING block,	
	13	MIB-0303-1142-0	HOLDER, VR.	
	14	M1305-10kΩ	Potentiometer, ZERO CAL. (R1)	
	15	MBK-0101-0175-5	KNOB, ZERO CAL.	
	16	MIB-0304-0133-1	SPACER, counter	
	17	YSNH-157D	SWITCH, rotary DISPERSION/DIV.	
	18	MZK-0107-0183	SPACER, front	
	19	MSP-0108-0133-0010-3	FILTER, FREQUENCY	
	20	MEM-0040-0115-7	KNOB, TUNING	
	21	MEM-0119-0112-2	PLATE, TUNING knob	
	22	781-6072C	KNOB, TUNING-FINE	
	23	MSN-0114-0112-1	PLATE, TUNING-FINE knob	
	24	MSN-0118-0112-2	PLATE, TIME/DIV. knob	
	25	MAK-0102-0112-1	BASE, plate TIME/DIV.	
	26	MEM-0040-0115-7	KNOB, TIME/DIV.	
	27	MBN-0119-0112-2	PLATE, TIME/DIV. knob	
	28	781-6072C	KNOB, MANUAL SWEEP	
	29	MSN-0115-0112-8	PLATE, MANUAL SWEEP knob	
	30	MEM-0041-0115-5	KNOB, DISPERSION/DIV.	
	31	MSN-0063-0112-0	PLATE, DISPERSION/DIV. knob	
	32	MSN-0062-0112-2	PLATE, BAND WIDTH knob	
	33	MXK-0105-0172-8	SPACER, knog	

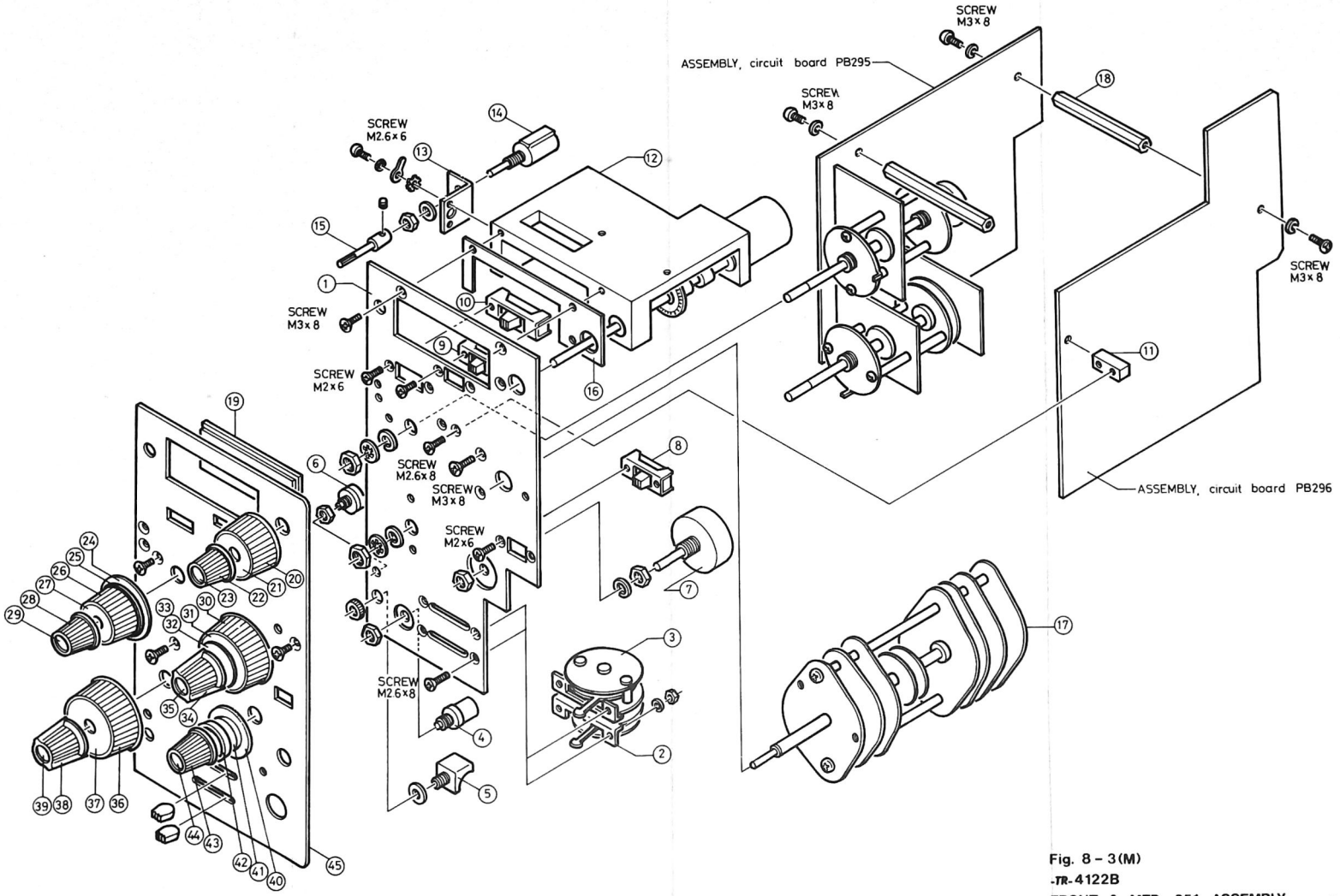


Fig. 8 – 3(M)
-TR-4122B
FRONT & MEP-251 ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-3	34	781-607IC	KNOB, BAND WIDTH	
	35	MBN-0120-0112-0	PLATE, knob	
	36	MEM-0041-0115-5	KNOB, REFERENCE LEVEL	
	37	MSN-0080-0112-2	PLATE, REFERENCE LEVEL (10dB Step)	
	38	781-6071C	KNOB, REF. LEVEL	
	39	MSN-0116-0112-6	PLATE, REF. LEVEL knob	
	40	MSN-0117-0112-4	PLATE, REFERENCE LEVEL (1dB Step)	
	41	MXK-0104-0112-4	BASE, REF. LEVEL FINE knob	
	42	MAK-0103-0112-9	SPACER, knob	
	43	781-6072C	KNOB, REF. LEVEL FINE	
	44	MSN-0114-0112-1	PLATE, REF. LEVEL FINE knob	
	45	MSB-0359-1134-0010-7	FRONT PANEL, right	

Fig. & INDEX No.		Stock No.	Description	
8-4	1	MIB-0305-0134-7	PLATE, input sub-panel	
	2	KCA-33A-01	BNC-UM CABLE, CAL. OUT. (Ca6)	
	3	THDC-HRMJ-NJ	CONNECTOR, INPUT (J1)	

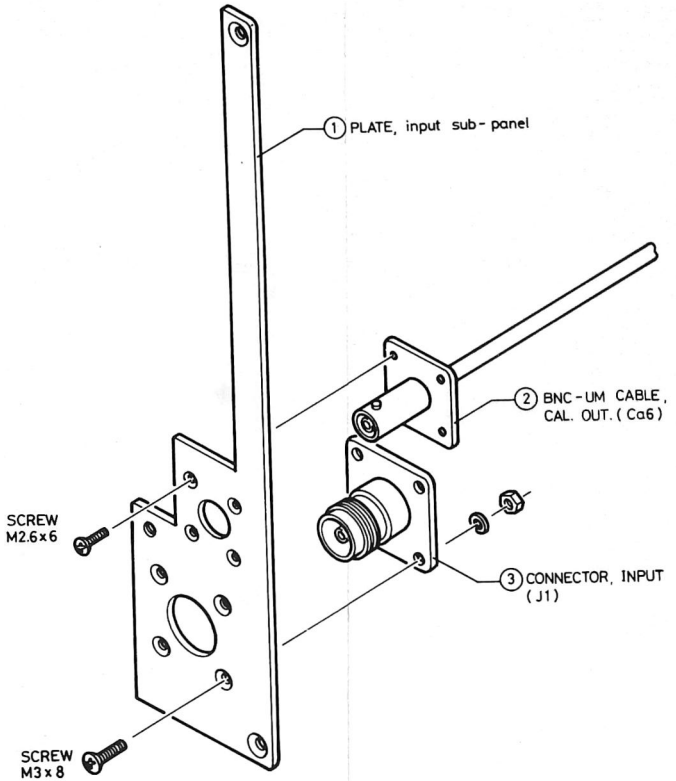


Fig. 8 -4(M)
-TR-4122B
INPUT PANEL ASSEMBLY

MECHANICAL PARTS LIST
CRT SUB-PANEL ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-5	1	MIB-0355-0134-2	PLATE, CRT sub-panel	
	2	BNF-2(Red)	NEON LAMP, AC LINE ON (N1)	
	3	BD-701R	LED LAMP, BATT. ON (D1)	
	4	RV16YN15SB1kΩ	RESISTOR, variable BASELINE CLIPPER	
	5	RVE16YN15R4M	RESISTOR, variable INTENSITY (R7)	
		RVE16YN15R4M	RESISTOR, variable FOCUS (R8)	
	6	THDC-HRMJ-NJ	CONNECTOR, TG. OUTPUT (J2)	
	7	RS-700A 1-1-6 L=20	SWITCH, rotary OUTPUT LEVEL (S1)	
	8	PSW-135	SWITCH, push (S2)	
	9	531-5702	SPACER	
	10	MIK-0124-0122-6	HOLDER, CRT	
	11	MEB-0311-0153-9	CRT BAND (Lower)	
	12	MEP-0113-0133-9	CUSHION, CRT, sponge A	
	13	MEP-0114-0132-6	CUSHION, CRT, sponge B	
	14	MXP-0111-0135-7	TAPE, plastic	
	15	MEB-0310-0153-1	CRT BAND (Upper)	

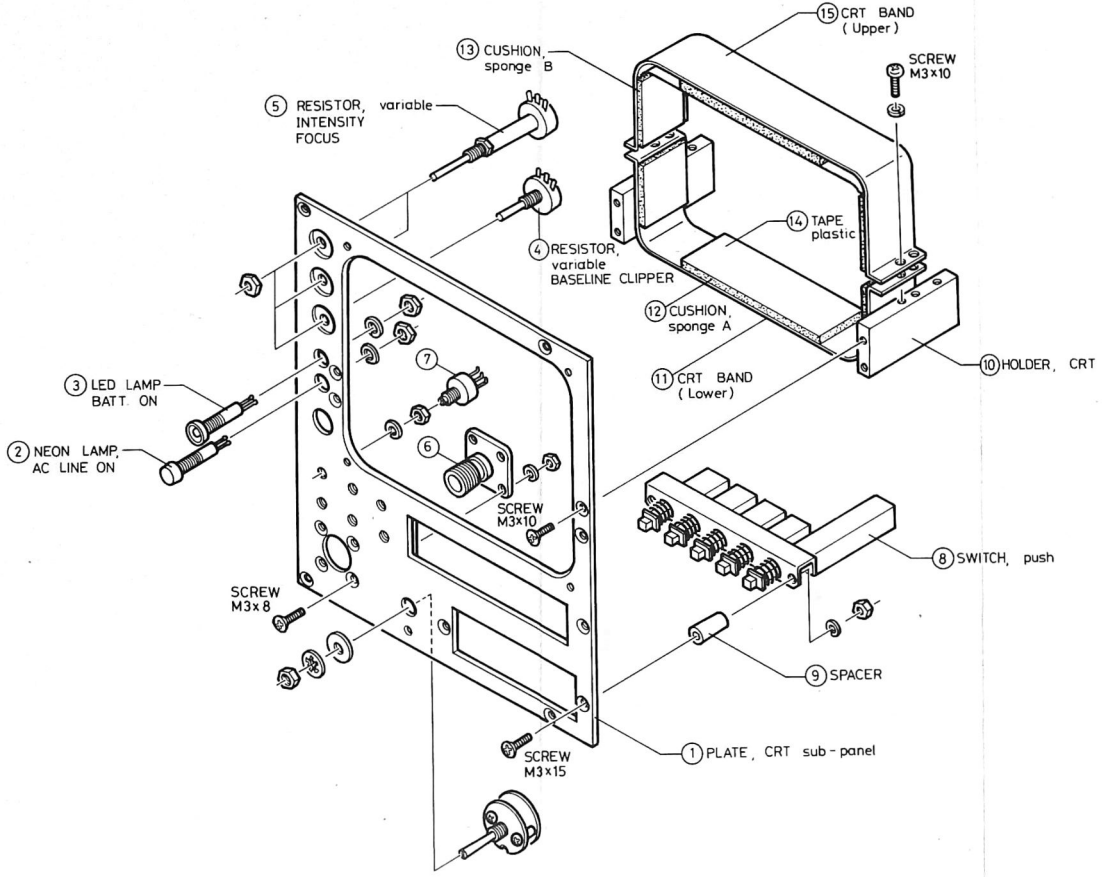


Fig. 8 - 5(M)
-TR- 4122B
CRT SUB - PANEL ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-6	1	MSB-0328	BRACKET, connector	
	2	BNC-078	CONNECTOR (J12,13,14) (Z,Y,X AXIS)	
	3	KCA-33-320	CONNECTOR (Ca-7) IF OUTPUT	
	4	57-40500	CONNECTOR (J7) AUX. OUTPUT	
	5	MIB-0352-1164-0	SHIELD CASE, IF	
	6	#807	HOLDER, circuit board	
	7	591-5734	SPACER	
	8	MXB-0365-0134-5	SHIELD PLATE A, IF section	
	9	MIB-0364-2164-3	COVER, IF shield case	

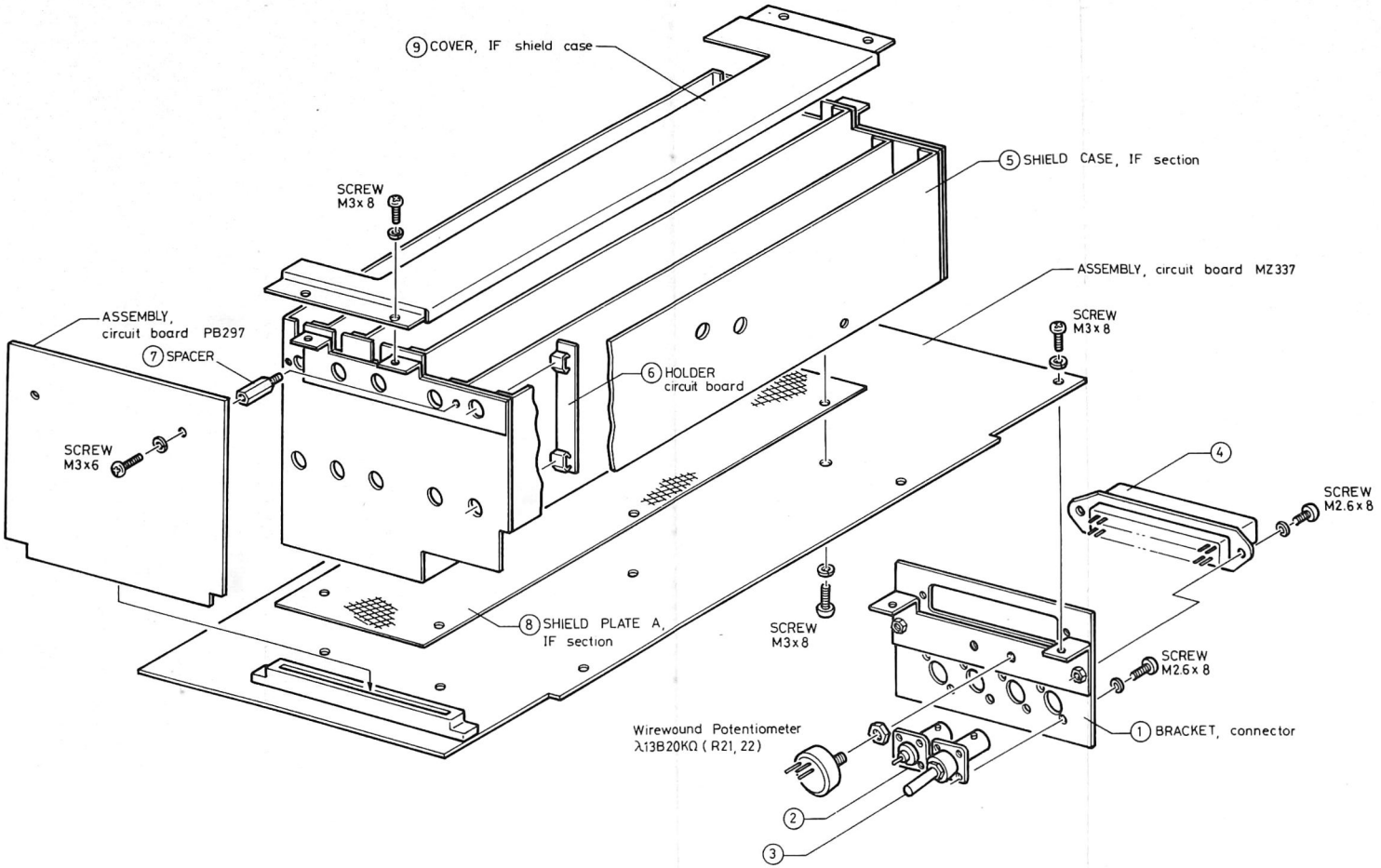


Fig. 8 – 6(M)
-TR-4122B
MOTHER BOARD ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-7	1	KC040-029-0190	SPRING	
	2	ETWJ-2.5	STOPPER, E RING	
	3	MIB-0307-0142-3	HOLDER, SHAFT power switch	
	4	MIK-0123-0175-4	SHAFT, power switch	
	5	MXP-0110-0172-3	CAP, power switch	
	6	MIK-0132-0122-9	BASE, Counter	
	7	SCT20L5NU3	LUG, P1	
	8	MIB-0376-2135-3	CHASSIS	
	9	MIK-0110-0185-9	SUPPORT	
	10	MIK-0133-0183-3	HOLDER, TG unit	
	11	NG-79-L	BUSH, rubber	
	12	S-1612A	CONNECTOR (J4)	
	13	MIB-0306-0142-5	BRACKET, CONNECTOR J4	
	14	MIB-0362-0144-6	SUPPORT A, RF unit	

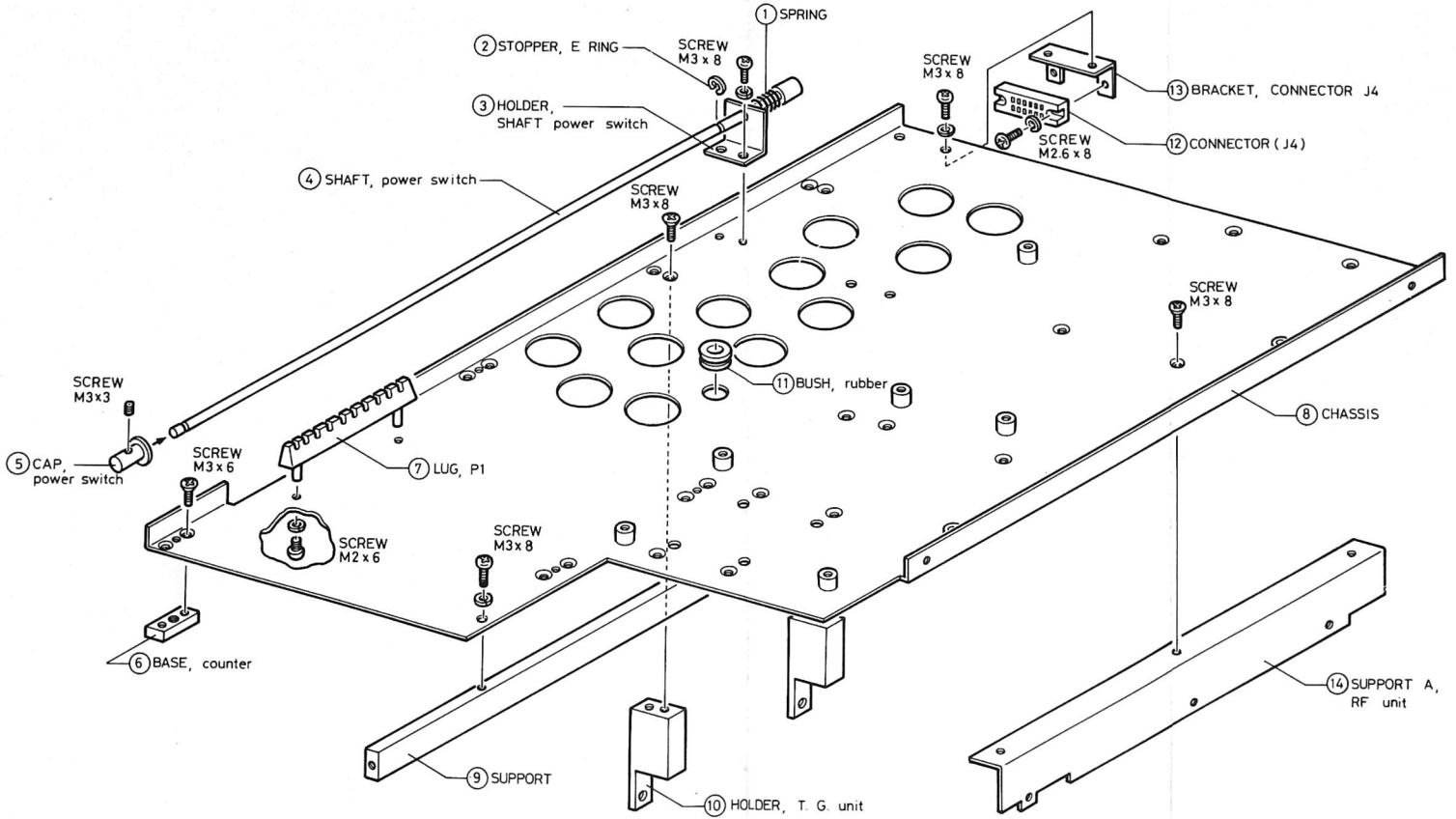


Fig. 8 - 7 (M)
-TR-4122B
CHASSIS

Fig. & INDEX No.		Stock No.	Description	
8-8	1	MSB-0356-1134-0010-0	FRONT PANEL, left	
	2	MXM-0036-0103-7	HOOD, CRT	
	3	MXP-0125-0135-7	FILTER, FREQUENCY COUNTER	
	4	781-5329A	KNOB, INTENSITY, FOCUS, B.CLIPPER	
	5	812-5134A	PLATE, knob	
	6	781-6071	KNOB, T.G. OUTPUT LEVEL	
	7	812-5134A	PLATE, knob	
	8	TB-0813	BUSH	
	9	781-5447	BUSH	
	10	MIB-0309-0143-8	STOPPER, CRT	

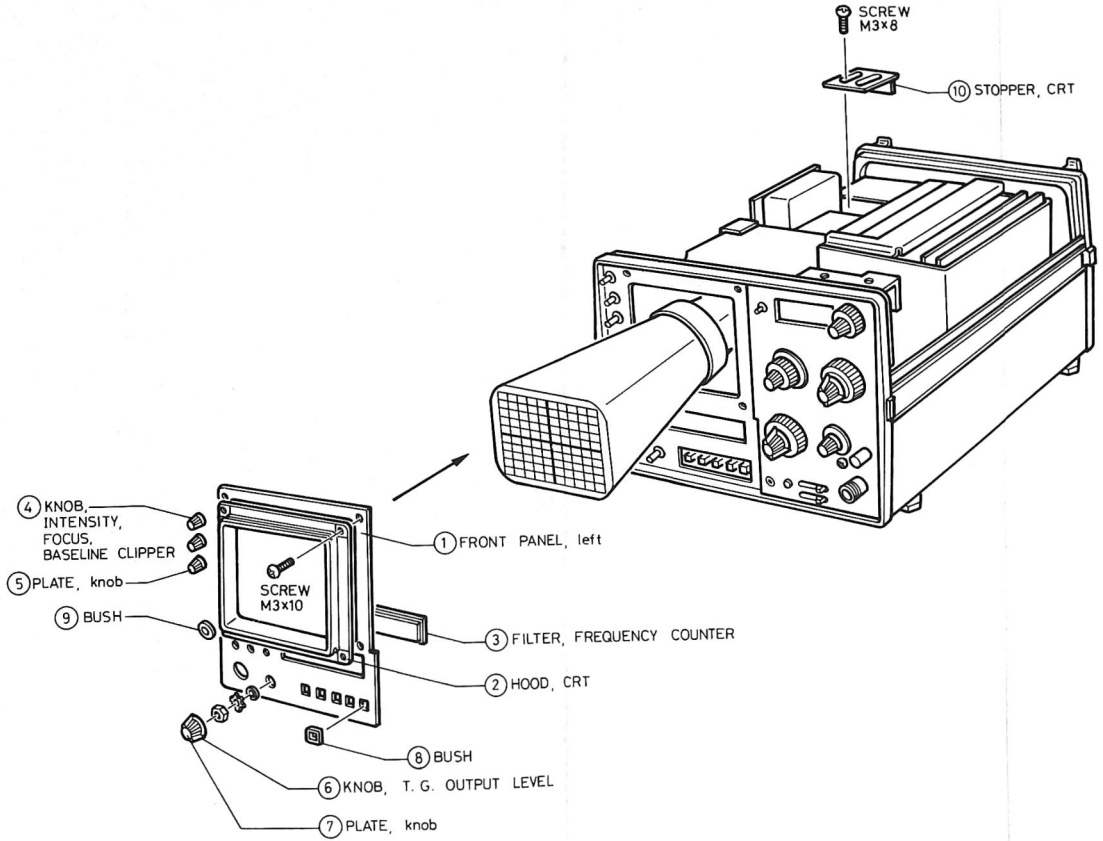


Fig. 8 - 8(M)
-TR- 4122B
CRT & FRONT

MECHANICAL PARTS LIST
CRT SHIELD CASE ASSEMBLY

Fig. & INDEX No.	Stock No.	Description	
8-9 1	MIB-0309-0143-8	STOPPER, CRT	
2	MIB-0308-0163-5	NECK-HOLDER, CRT	
3	MIK-0125-0122-4	HOLDER, CRT	
4	MEB-0351-0165-7	SHIELD CASE, CRT	
5	MEP-0115-0133-5	CUSHION, CRT, sponge C	
6	MXP-0112-0133-6	TAPE, plastic	

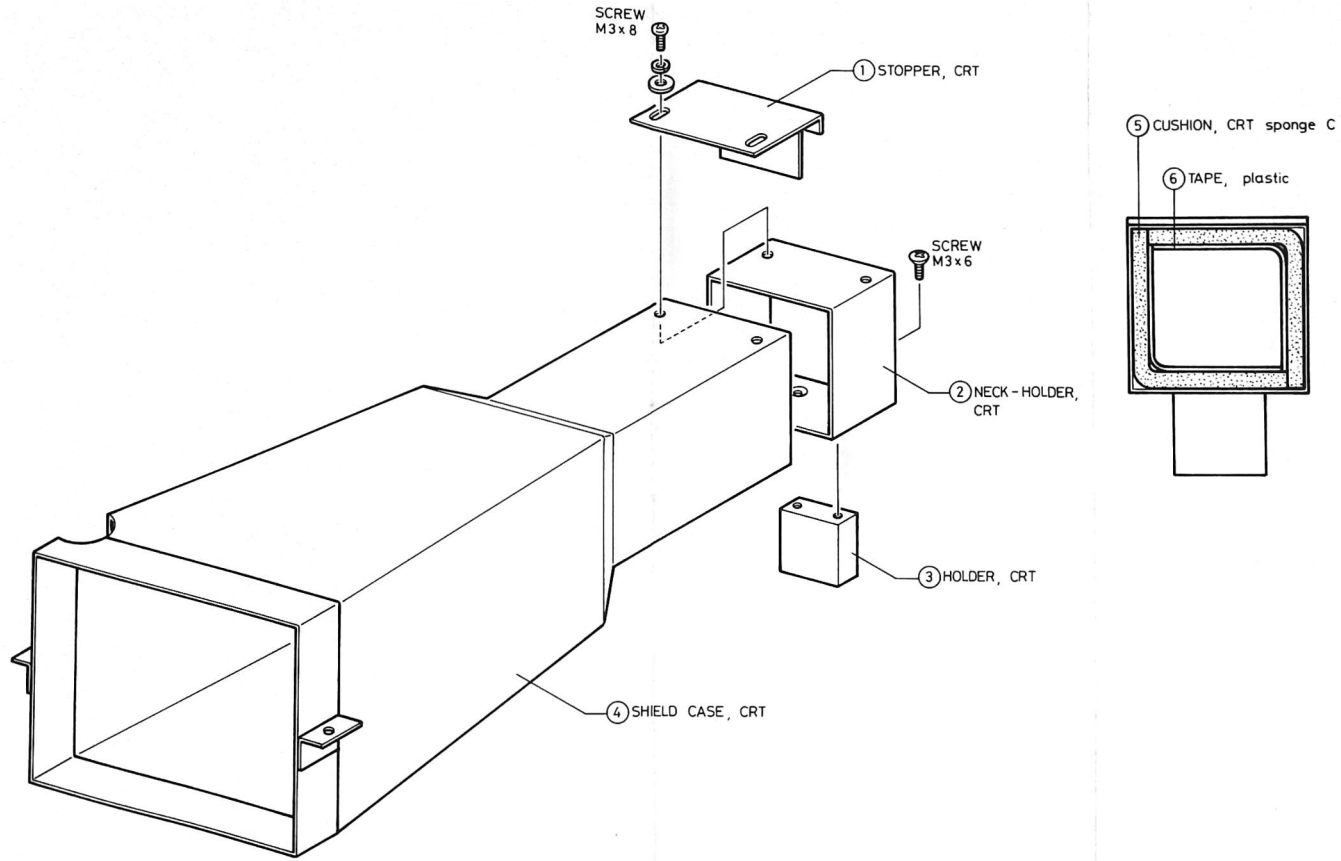


Fig. 8-9(M)
-TR-4122B
CRT SHIELD CASE ASSEMBLY

-TR-4122B
MECHANICAL PARTS LIST
YIG SHIELD CASE ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-10	1	PCN6-105-2.5E	CONNECTOR (J30)	
	2	NG-79-C	BUSH, rubber	
	3	MEP-153	YIG TUNED OSC.	
	4	MEB-0316-0163-6	COVER, YIG Shield case	
	5	MIB-0315-0133-7	BASE C, YIG tuned OSC.	
	6	MIK-0126-0123-0	BASE A, YIG tuned OSC.	
	7	MIK-0127-0123-8	BASE B, YIG tuned OSC.	
	8	MEB-0368-0103-7	SHILED CASE, YIG tuned OSC.	
	9	MEP-256	COUPLER	
	10	MIB-0367-0104-3	CHASSIS, YIG tuned OSC.	

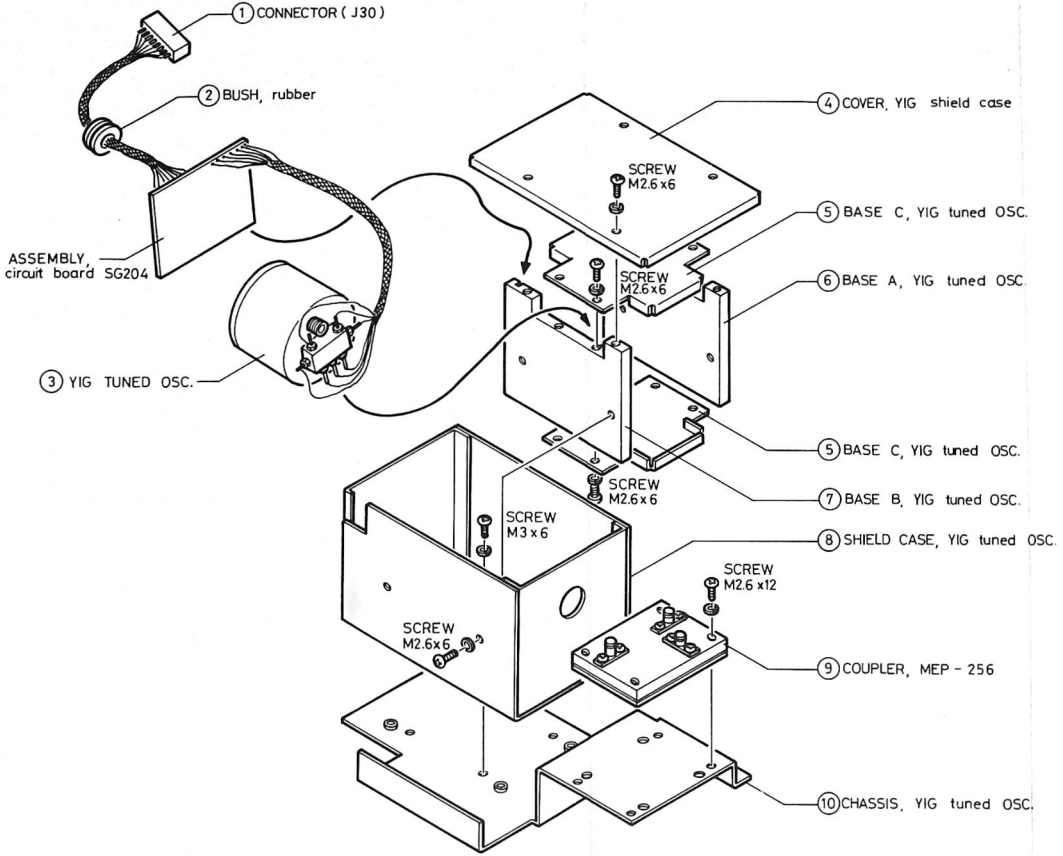

① CONNECTOR (J30)
② BUSH, rubber
ASSEMBLY, circuit board SG204
③ YIG TUNED OSC.
④ COVER, YIG shield case
SCREW M2.6x6
⑤ BASE C, YIG tuned OSC.
SCREW M2.6x6
⑥ BASE A, YIG tuned OSC.
⑤ BASE C, YIG tuned OSC.
SCREW M2.6x6
⑦ BASE B, YIG tuned OSC.
SCREW M3x6
⑧ SHIELD CASE, YIG tuned OSC.
SCREW M2.6 x12
SCREW M2.6x6
⑨ COUPLER, MEP - 256
⑩ CHASSIS, YIG tuned OSC.

Fig. 8 - 10 (M)
-TR-4122B
YIG SHIELD CASE

Fig. & INDEX No.	Stock No.	Description	
8-11 1	MSB-0360-1134-0010-4	PANEL, rear	
2	FH-003	HOLDER, fuse	
3	TB-1116	BUSH	
4	TOP-23A	LUG, ground	
5	MBK-0122-0172-4	FOOT	
6	NF-13502	CABLE, AC power	
7	JRC21RG-16S	CONNECTOR, EXT. DC INPUT (J1)	
8	JRC21RC	CAP, connector J1	
9	TP-1036B	TRANSFORMER, power (T1)	
10	MIB-0317-0143-1	HOLDER A, transformer	
11	MIB-0375-1103-5	HOLDER B, transformer	
12	MZK-0128-0183-3	SPACER	
13	MEC-0006-0105-3	FRAME, rear	
14	USN-00905-A	FASTENER, Sheet nut	

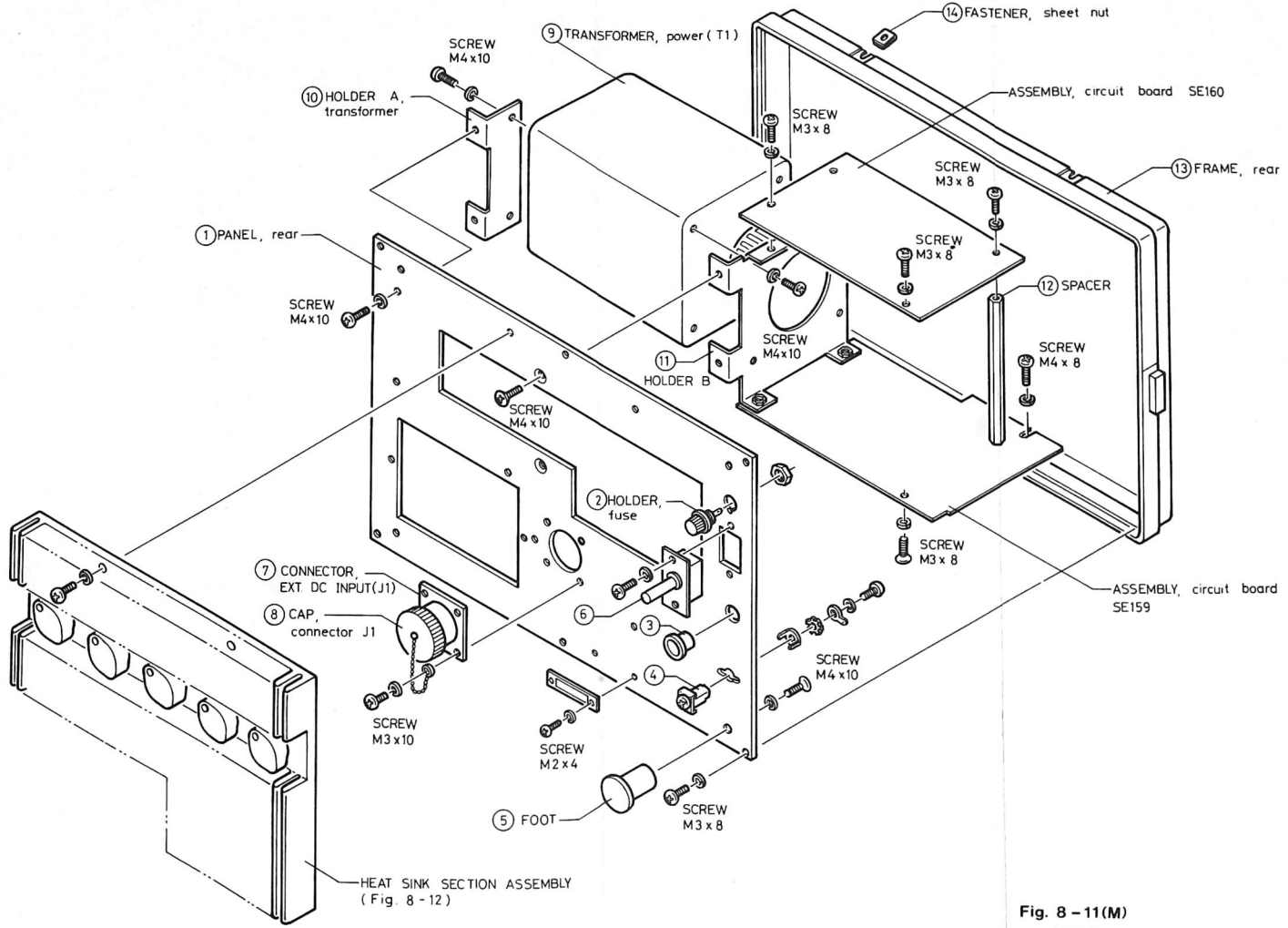


Fig. 8 – 11(M)
***-TR-* 4122B**
MEP – 252 ASSEMBLY

MECHANICAL PARTS LIST
HEAT SINK SECTION ASSEMBLY

Fig. & INDEX No.	Stock No.	Description	
8-12 1	MBK-0121-1104-7	HEAT SINK, IC	
2	Z-2104P-00	COVER for IC1, Q1,Q2,Q3	
3	Z-2103P-00	COVER for Q4	

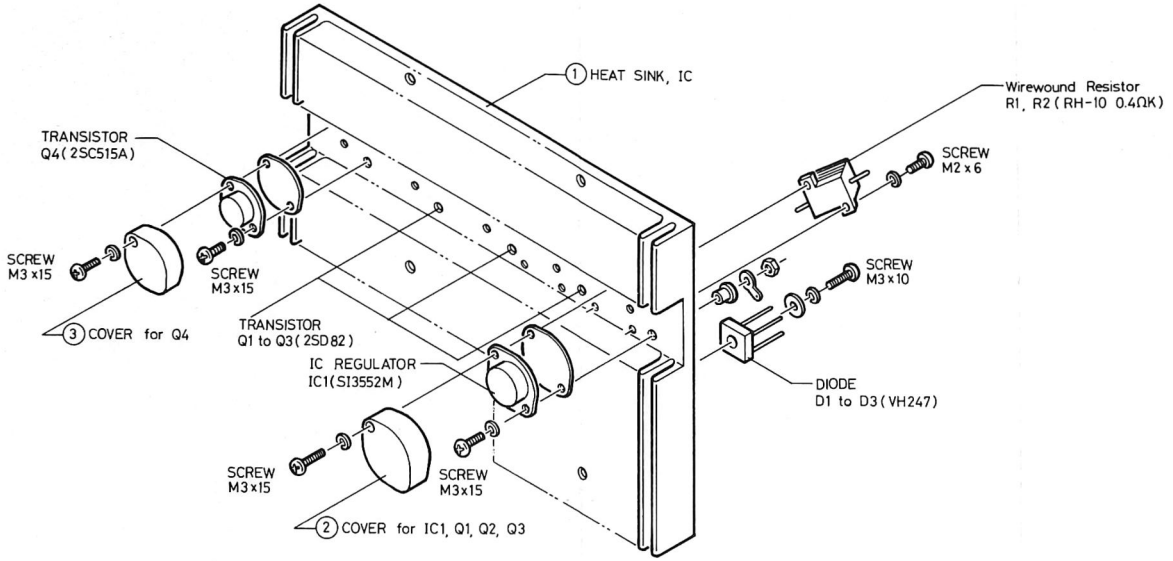


Fig. 8 – 12 (M)
-TR-4122B
HEAT SINK SECTION ASSEMBLY

MECHANICAL PARTS LIST
MEP-260 ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-13	1	MIB-0339-0133-7	COVER, RF AMP.	
	2	50-645-4526-89	CONNECTOR (J1,J2)	
	3	MEK-0117-1103-9	CASE, RF AMP.	
	4	PF-5-175	CONNECTOR, terminal standoff	
	5	MSK-0116-1104-0011-3	COVER, bottom Frequency Counter	
	6	MEK-0115-1104-3	SHIELD CASE, Counter	
	7	MIB-0373-1134-3	COVER, top Frequency Counter	
	8	531-5702	SPACER	
	9	50-645-4526-89	CONNECTOR (J3)	

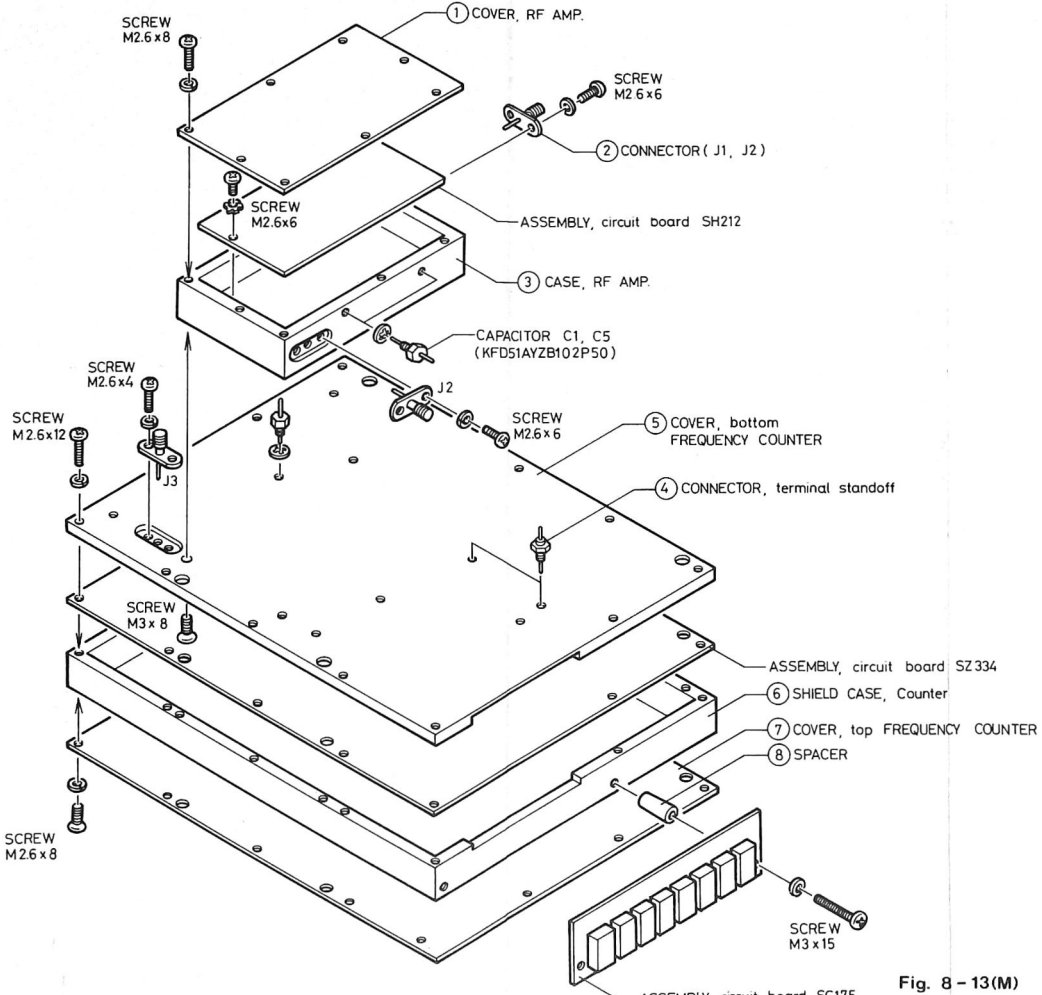


Fig. 8 – 13(M)
***-TR-* 4122B**
MEP – 260 ASSEMBLY

Fig. & INDEX No.		Stock No.	Description	
8-14	1	MSB-0574-0134-0010-7	SHIELD CASE-COVER, T.G.	
	2	MSB-0575-0134-0010-6	SHIELD CASE-COVER, T.G.	
	3	MEK-0118-0104-8	SHIELD CASE, T.G.	
	4	MEK-0119-0104-6	CASE-COVER, T.G.	
	5	MEK-0120-1104-2	CASE-COVER, T.G.	

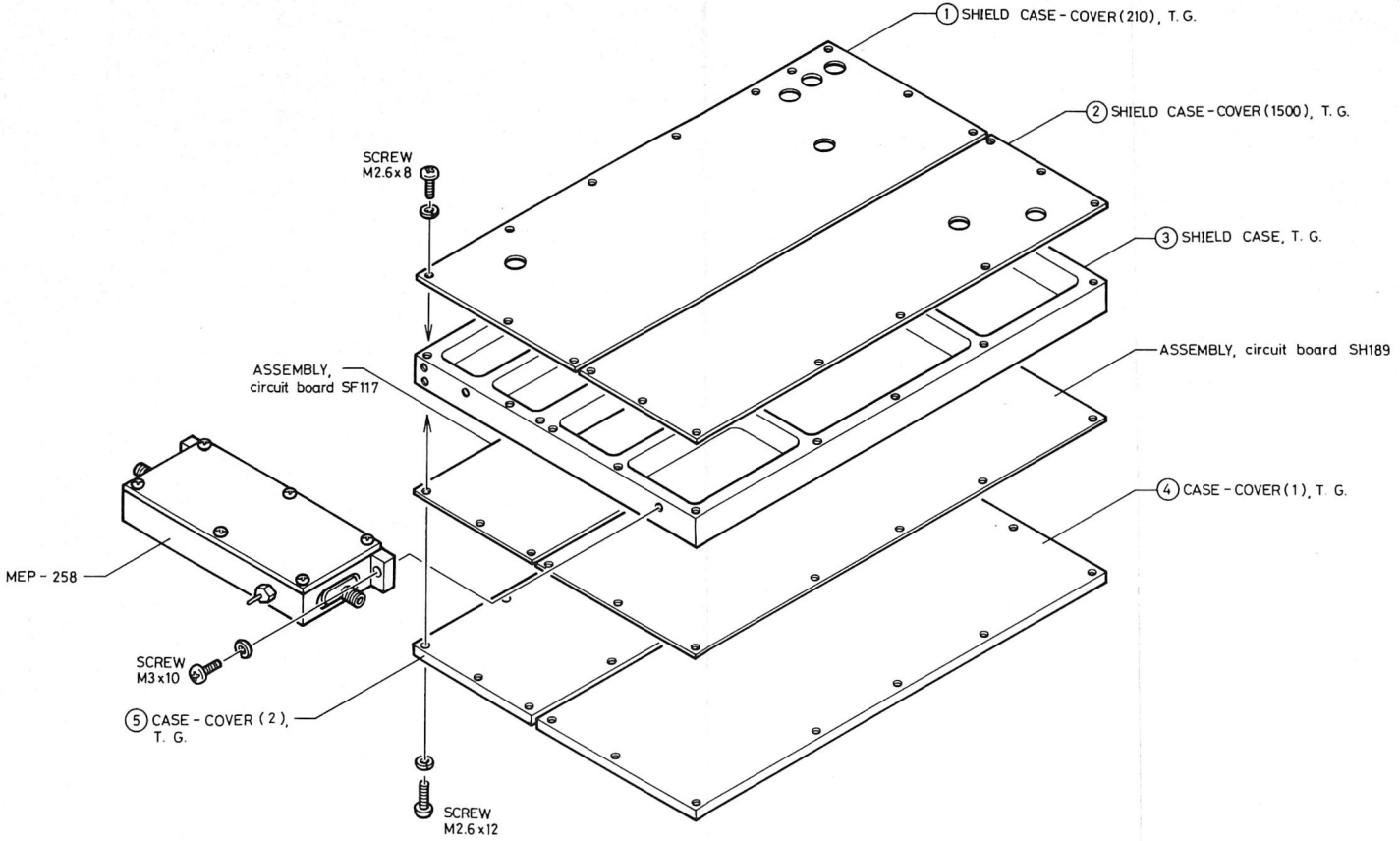

① SHIELD CASE - COVER (210), T. G.
② SHIELD CASE - COVER (1500), T. G.
③ SHIELD CASE, T. G.
④ CASE - COVER (1), T. G.
⑤ CASE - COVER (2), T. G.
SCREW M2.6x8
ASSEMBLY, circuit board SF117
ASSEMBLY, circuit board SH189
MEP - 258
SCREW M3x10
SCREW M2.6x12

Fig. 8 - 14 (M)
-TR-4122B
MEP - 257 ASSEMBLY

Fig. & INDEX No.	Stock No.	Description	
8-15 1	MSB-0372-1134-0	COVER, top	
2	MEK-0113-1104-7	SHIELD-CASE, RF unit	
3	MEK-0114-1104-5	COVER, buttom	

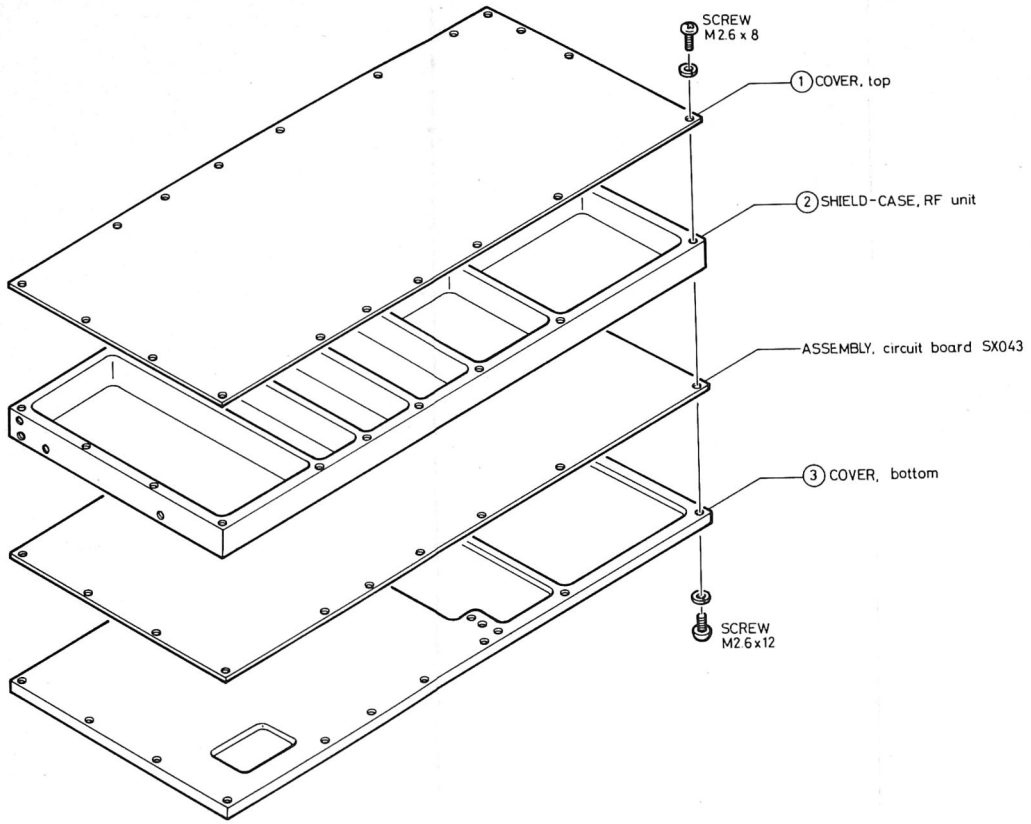
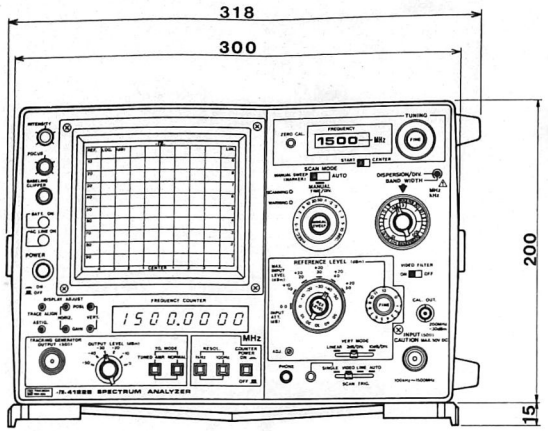
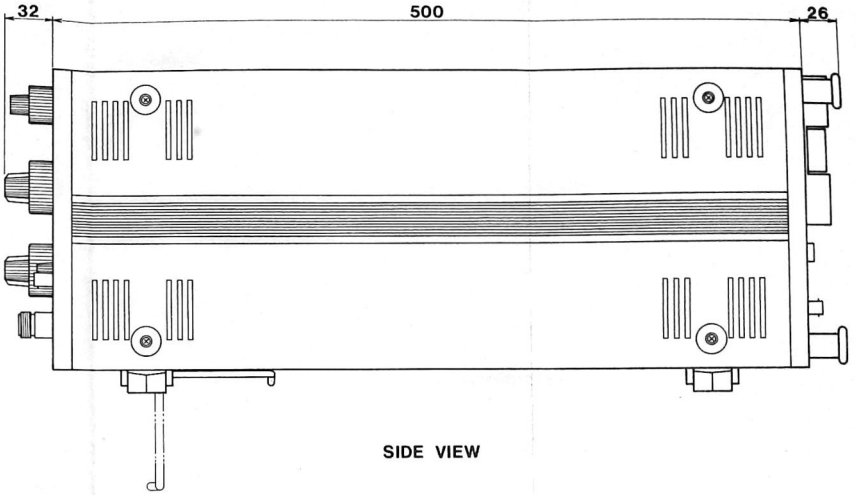


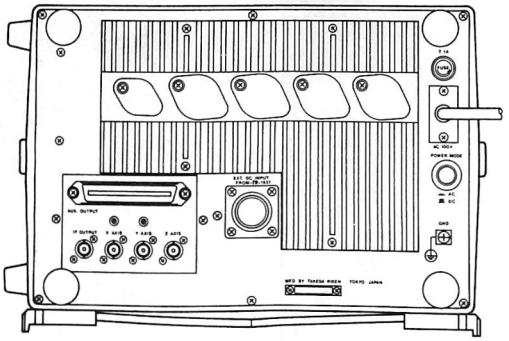
Fig. 8 – 15(M)
-TR-4122B
MEP – 255 ASSEMBLY



FRONT VIEW



SIDE VIEW



REAR VIEW

-TR-4122B
EXTERNAL VIEW

Appendix Technical Terms

IF Bandwidth
A Spectrum Analyzer uses Band Pass Filter (B.P.F.) in analyzing individual frequency components which are composed in an input signal. 3dB bandwidth of a B.P.F. is called an IF Bandwidth. [Fig. a] The characteristic of a B.P.F. must be considered in appropriate from depending on the sweep width and sweep speed. ***-TR-* 4122B** is designed so that settings are automatically selected to the best. Spectrum resolution is improved as the bandwidth is set narrower in general so that sometimes the resolution of a Spectrum Analyzer is expressed with the narrowest IF Bandwidth. [Fig. b]

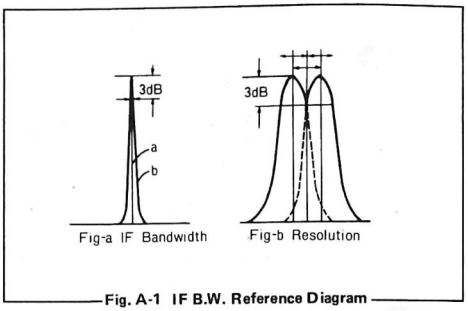


Fig-a IF Bandwidth Fig-b Resolution

Fig. A-1 IF B.W. Reference Diagram

Gain Compression
If an input signal is applied in excess of a level, CRT display does not indicate correct level but shows as if increase of the input signal level were compressed. This phenomenon is called Gain Compression and defines linearity of the input signal range of the Spectrum Analyzer. Practically used is the range up to the compression of 1dB.

Input Sensitivity
Input Sensitivity is an ability of a Spectrum Analyzer to detect the smallest signal. It is directly related with the noise generated in the Spectrum Analyzer itself and depends on the IF Bandwidth being used. Input Sensitivity normally means the Average Noise Level at the least IF Bandwidth of the Spectrum Analyzer.

Maximum Input Level
It is the maximum permissible level at RF. input of the Spectrum Analyzer. Permissible level can be changed in accordance with provision of input attenuator.

Residual FM
Residual FM is used to mean short time stability of the local oscillator group built in a Spectrum Analyzer, and the drifting frequency bandwidth for a unit time is mentioned in peak to peak. It also indicated the measurement limit in measuring residual FM for the object under measurement.

Residual Response
It is to define the degree of level to which the spurious signal generated in the Spectrum Analyzer is restrained. It is due to a leakage signal like local oscillator output of the Spectrum Analyzer, and care is required in the case of analyzing extremely small input signal.

Quasi Peak Value Measurement
Reception interference noise in radio communications normally appears in a form of impulse. Such an interference energy is objectively evaluated with a value proportional to the quasi peak value. Since it is necessary to conclude the measurement range and detection time constant, etc. in measurement evaluation, quasi peak value is decided to indicate the measurement value. In accordance with the conclusion, there are JRTC Specifications in Japan and C.I.S.P.R. Specifications in U.S.A. Takeda Riken's ***-TR-*4132/4132N** Spectrum Analyzer is the first to have adapted C.I.S.P.R. Specifications.

Frequency Response
This term is generally used to express an amplitude (frequency) characteristic of a frequency. With a Spectrum Analyzer, it means the frequency characteristic (flatness) of input attenuator and mixer, etc. for respective input frequency and is indicated in $\pm\Delta$ dB.

Scan Width
This is to express display range of horizontal axis (frequency domain) on CRT and includes the following display modes:
Full Scan: sweeps over the measurement range of the Spectrum Analyzer.
Dispersion/DIV.: is accurately calibrated frequency scale. Frequency axis is arbitrarily selected and sweep is effected from wide band to narrow band.
Zero Scan: does not perform frequency sweep but is tuned only to the frequency displayed at CRT display center. In this mode, the horizontal axis is not frequency but represents time axis as set by scan time.

Spurious
Spurious is undesired signal other than objective signal and is classified in accordance with characteristic of the signal as follows:
Harmonic Spurious: Specifies level of the harmonic which is generated in the Spectrum Analyzer (normally at mixer circuit) when ideal nondistorted signal is applied to the Analyzer. It also expresses the ability of harmonic distortion measurement.
Near-by Spurious: is the small spurious which appears in the neighbor of the Spectrum on the display when a pure single spectral signal is applied to a Spectrum Analyzer.
Nonharmonic Spurious: is called a residual spurious that is spurious of the frequency inherently generated in the Spectrum Analyzer.

Noise Sideband
Noise Sideband is an ability commonly used in expressing oscillation purity of an oscillator. With a Spectrum Analyzer, the noise generated in local oscillators and phase lock loops in particular appears in the neighbor of the spectrum under measurement and disturbs performance of the Spectrum Analyzer. It is therefore

necessary for such an instrument to specify the noise sideband of its own to mention the range where noise sideband of external signals can be analyzed. Typical specifications adapted to a Spectrum Analyzer are shown below.

The one specifies the Noise Sideband being −70dB below the signal peak, 20kHz away from the carrier, with 1kHz IF Bandwidth. Generally used is an expression of the energy existing in a 1Hz bandwidth. [Fig. b] If the former is expressed in this way of the latter, the signal in 1Hz bandwidth is about 10 log 1Hz/1kHz that is about −30dB more lower, bearing in mind −70dB at 1kHz bandwidth. So, the former can be replaced to read −100dB/Hz, 20kHz away from the carrier with 1kHz Bandwidth.

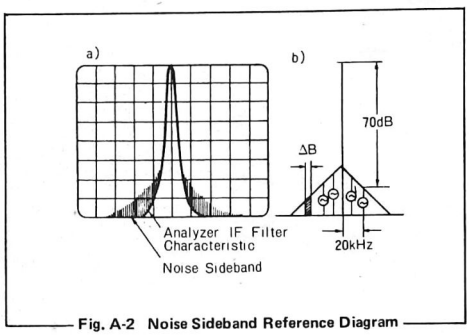


Fig. A-2 Noise Sideband Reference Diagram

Bandwidth Selectivity

The characteristic of Band Pass Filter is not of a normal rectangle but is given with an attenuation characteristic similar to that in a gauss distribution. Consequently, in the case there are two signals mixed in neighbor, the smaller signal is hidden in the skirt of the larger one as shown in Fig. (a) below. It is therefore necessary to specify the bandwidth at an appropriate area (60dB), and the ratio of the bandwidths at 3dB and 60dB points in expressed as Bandwidth Selectivity.

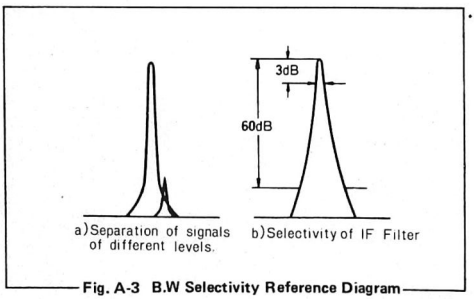


Fig. A-3 B.W Selectivity Reference Diagram

Bandwidth Accuracy

It is the accuracy of bandwidth for IF Filter and is expressed with the deviation to the nominal value at the point 3dB below the peak. This ability is not necessarily considered in level measurements for normal continued signals but in level measurements for noise signals.

Bandwidth Switching Accuracy

Appropriate number if IF Filter is prepared and used by switching in analyzing a signal into spectrum so as to obtain best resolution for the scan width. The IF Filter retains inherent loss individually, and switching to the other causes an error corresponding to respective loss even in the case of measuring the same signal. This is defined as Bandwidth Switching Accuracy.

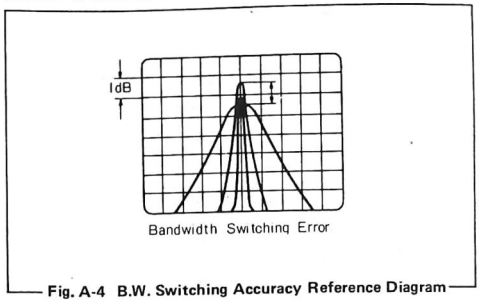


Fig. A-4 B.W. Switching Accuracy Reference Diagram

Reference Level Display Accuracy

Absolute level of the input signal is read with a Spectrum Analyzer display in reference to the horizontal top line of the graticule. The level set to the horizontal top line is called the reference level. The reference level can be selected in accordance with the settings of IF GAIN and Input Attenuator in the display of dBm or dBμ. The absolute accuracy of the display is the reference level accuracy.

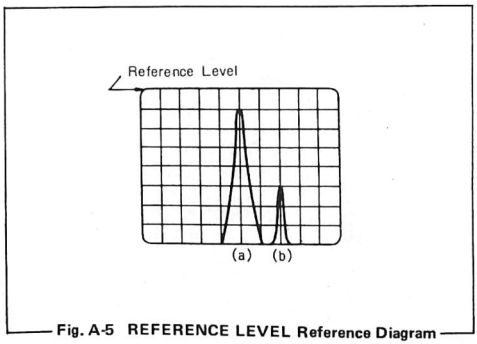


Fig. A-5 REFERENCE LEVEL Reference Diagram

V.S.W.R. (Voltage Standing Wave Ratio)

It is a constant to represent impedance matching condition and is expressed by a ratio of the maximum and minimum values among the standing waves which are composed by travelling waves and reflected waves at the condition the Spectrum Analyzer is acting as a load to an ideal nominal impedance source. This is another expression of reflection coefficient and reflection loss, which relation is described below.

In the case the signal Eo supplied from the transmitter

side is completely transmitted to the receiver (a Spectrum Analyzer) without any impedance loss, the signal EI received must be identical to EO. If the signal is not perfectly transmitted due to mismatching, etc. but there are reflected wave received again at the level ER, the reflection coefficient is expressed as follows:

Reflection coefficient m = ER/EO

The ratio of reflected wave ER to travelling wave EO is reflection loss which is 20 log ER/EO [dB]

V.S.W.R. = (EO + ER) / (EO − ER).

The relationship with reflection coefficient is:

V.W.W.R. = (1 + |m|) / (1 − |m|)

V.S.W.R. is in a range from 1 to indefinite, and the matching is better as V.S.W.R. is close to 1.

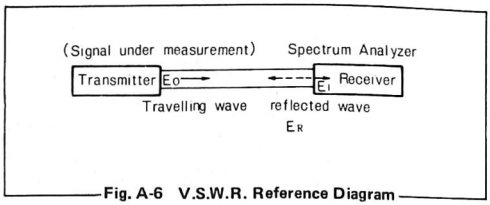


Fig. A-6 V.S.W.R. Reference Diagram

Spurious Response

It is the harmonic distortion generated in the input mixer circuit as the input level goes up, as shown in the figure below. The level range available in nondistortion depends on fundamental input level and an example shown in the figure is −70dB for the input level of −30dBm. In practice, the input attenuator is effectively used to decrease the signal level to get it appropriate.

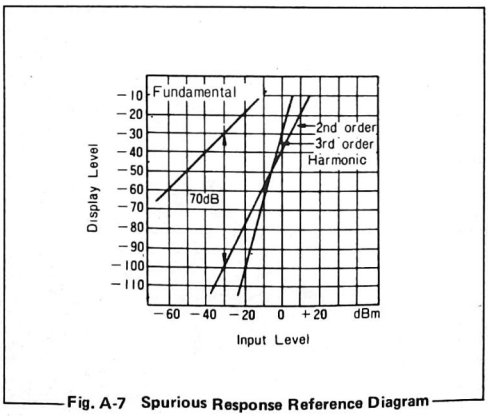


Fig. A-7 Spurious Response Reference Diagram

YIG-tuned Oscillator

YIG-turned Oscillator was reported by Griffiths in 1946 for the first time. Ferite in Garnet representing YIG (Yttrium Iron Garnet) single crystal has an extremely sharp electro-spin resonance in frequency has a linear proportional relationship with the impressed DC magnetic field over a wide frequency range. It enables wide-band electronic tuning by varying excitation current of the magnet which causes a DC magnetic field. Takeda Riken uses YIG Oscillator for the local oscillators of its Spectrum Analyzers and ***-TR-5200*** series Automatic Microwave Frequency Counters.

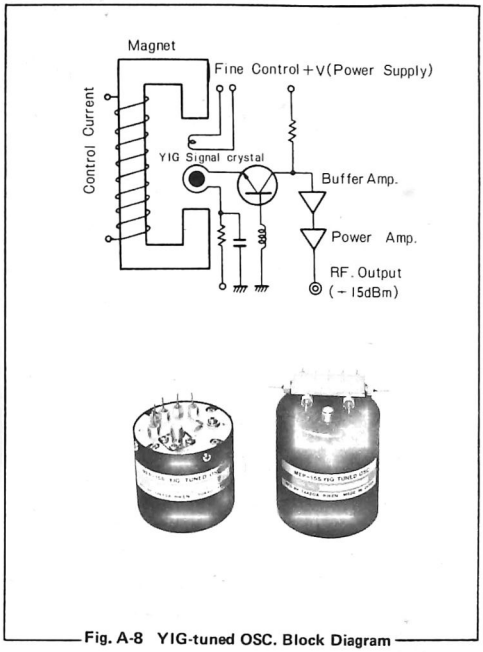


Fig. A-8 YIG-tuned OSC. Block Diagram